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GENETIC STOCK IDENTIFICATION

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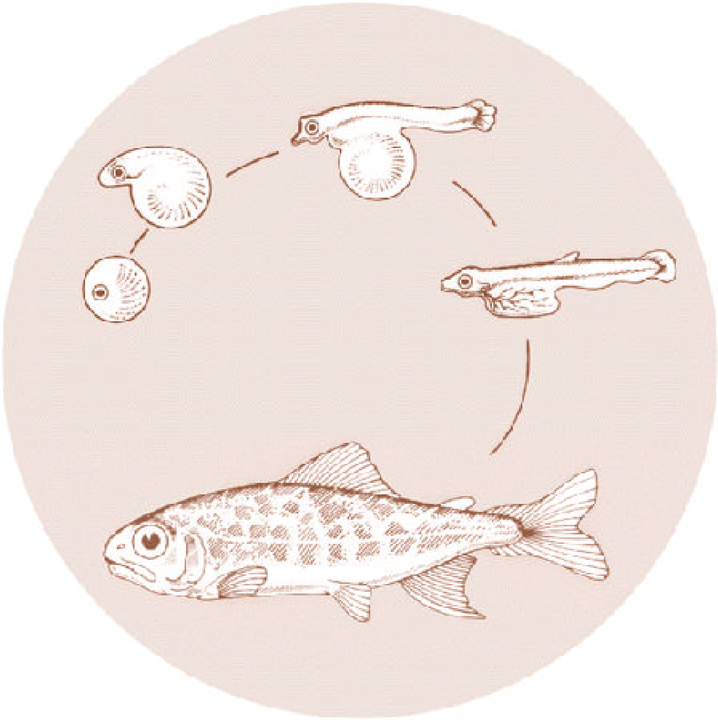

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GENETIC STOCK IDENTIFICATION

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ABSTRACT

The results of the first year's investigation of a S-year plan to demonstrate and develop a coastwide genetic stock identification (GSI) program are presented. The accomplishments under four specific objectives are outlined below:

1. Improved Efficiency through Direct Entry of Electrophoretic Data into the Computer. A program is described that was developed for direct computer entry of raw data. This program eliminated the need for key- to-tape processing previously required for estimating compositions of mixed fisheries, and thereby permits immediate use of collected data in estimating compositions of stock mixtures.

2. Expand and Strengthen Oregon Coastal and British Columbia Baseline Data Set. Electrophoretic screening of approximately 105 loci of samples from 22 stocks resulted in complete data sets for 35 polymorphic and 19 monomorphic loci. These new data are part of the baseline information currently used in estimating mixed stock compositions.

3. Conduct a Pilot GSI Study of Mixed Stock Canadian Troll Fisheries off the West Coast of Vancouver Island. A predominance of lower Columbia River (fall run), Canadian, and Puget Sound stocks was observed for both 1984 and 1985 fisheries . Stocks other than Columbia River, Canadian, and Puget Sound contributed an estimated 13 and 5% respectively, to the 1984 and 1985 fisheries .

4. Validation of GSI for Estimating Mixed Fishery Stock Composition. Baseline data from the Columbia River southward were used to simulate northern and central California fisheries . These simulations provided estimates of accuracy and precision for mixed sample sizes ranging from 250 to 1,000 individuals. Sacramento River stocks had a heavier weighting in the central (89%) than in the northern (25%) fishery. Accuracy and precision increased

for both fisheries as sample sizes increased and also were better for those estimates that were over 5%. Extrapolations from these estimates indicated that sample sizes of 2,320 and 2,869 would be required to fulfill coefficients of variation (SD/estimated contribution) of 20% with respective confidence intervals of 80 and 95% in stock groupings of the northern fishery. Similarly, sample sizes of 2,450 and 3,030 would be required in the central fishery.

A concluding section noted that these investigations are part of an effort involving many agencies. The requirements for simulation preceding actual sampling of stock mixtures and for continued monitoring and development of baseline data sets were emphasized.

CONTENTS

INTRODUCTION

Work accomplished during the first year of a 5-year plan to demonstrate and develop an operational coas twide genetic stock identification (GSI) program for chinook salmon is the subject of this report. The program addresses Act ion Item 38, Improved Harvest Controls, of the Northwest Power Planning Council's (NPPC) Five Year Plan[1/] which reads:

> "Share funding, with the fishery management agencies, of a five-year demonstration program to determine the effectiveness of using electrophoresls as a fishery management tool. Initiate the demonstration program during the 1985 ocean fishery season or subsequent seasons if and when they occur."

The NPPC summary justification for this action plan is as follows:

> "While most measures in the program are likely to benefit many runs of fish, it is particularly important to monitor and influence harvest management decisions for the benefit of all Columbia River anadromous fish"....(p. 121)

Further, improved harvest controls resulting from the use of new stock identification tools such as the GSI will protect and optimize ratepayers' Investments in enhancement program thus fulfilling the second goal of the action plan:

1/ Columbia River Basin Fish and Wildlife Program adopted 15 November 1982 amd amended 10 October 1984 pursuant to Sect. 4(h) of the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501).

> "The Council also believes that improving harvest controls to increase salmon and steelhead returns to the Columbia River Basin is essential to protection of the ratepayer investment...Initiation of electrophoreses and known-stock fisheries studies under the program is an attempt to remedy this problem."

Improved harvest controls demand new tools to fill the urgent need for more comprehensive and timely stock composition information for ocean fisheries of chinook salmon. This is especially true for untagged hatchery and wild stocks. The need will become more critical to ensure protection and proper allocation of Columbia River stocks in ocean fisheries under the US/Canada Interception Treaty. Thus, new stock identification tools are needed for pre-season planning, in-season regulation and evaluation of harvest regulatory programs. GSI is a valuable tool necessary for meeting this need (Milner et al. 1985).

The specific objectives of the National Marine Fisheries Service (NMFS) for this year's work were the following:

1. Improved operation efficiency through direct entry of electrophoretic data into the computer.

2. Expand and strengthen Oregon coastal and British Columbia baseline data set.

3. Conduct a pilot GSI study of mixed stock Canadian troll fisheries off the west coast of Vancouver Island and in the Georgia Strait.

4. Validation of GSI for estimating mixed fishery stock composition.

MATERIALS AND METHODS

Computer Program for Data Entry

A prototype computer program (Fortran release level 3.4.1) for direct entry of electrophoretic data developed at the Northwest and Alaska Fisheries Center2/ for use on the Burroughs3/ mainframe computer was tested and refined for incorporation into routine GSI operations.

Electrophoresis

Samples from the stocks used in this study were collected by Washington Department of Fisheries (WDF), Oregon Department of Fish and Wildlife (ODFW), California Department of Fish and Game (CDFG), and Canadian Department of Fisheries and Oceans (CDFO) and electrophoretically analyzed by the NMFS at the Manchester Marine Experimental Station at Manchester, Washington. Eye (vitrous fluid), liver, heart, and skeletal muscle were sampled from each baseline stock. Only eye fluid and skeletal muscle tissues from adult fish were collected from the British Columbia troll fishery. All samples were transported on dry ice to our laboratory and stored at -90°C until they were processed.

Protein extraction procedures and electrophoretic methods generally followed May et al. (1979). Three buffer systems were used: (1) gel, 1:4 dilution of electrode solution, electrode, TRIS (0.18 M), boric acid (0.01 M), with EDTA (0.004 M), pH 8.5 (Markert and Faulhaber 1965); (2) gel, 1:20 dilution of electrode solution, electrode, citric acid (0.04 M), adjusted to pH 7.0 with N-(3-aminopropyi)-morpholine (Clayton and Tretiak 1972) with EDTA

2/ Programmed by Kathy Gorham, NWAFC.

3/ Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

(0.01 M) [(2a): same as (2) except gel, 1:5 dilution of electrode solution with 0.23 mM NAD added, electrode, adjusted to pH 6.5 with 0.23 mM NAD added to cathodal tray]; and (3) gel, TRIS (0.03 M), citric acid (0.005 M), 1% (final cont.) electrode buffer, pH 8.4, electrode, lithium hydroxide (0.06 M), boric acid (0.3 M), EDTA (0.01 M), pH 8.0) (modified from Ridgway et al. 1970) [(3a): same as (3) except with no EDTA in gel or electrode solutions].

Baseline Stock Sampling

Approximately 200 fish from each of 22 hatchery and wild stocks representing spring, summer, and fall run chinook salmon timings were sampled from four geographical areas: Columbia River, Oregon coast, Fraser River, and British Columbia coast (Table 1). A sample of 100 of the fish from each stock were profiled for genetic variations, and the remaining fish were stored for a tissue bank at -9O'C. These tissue samples will be available for adding new genetic information to the existing baseline data set and for standardizing the collection of electrophoretic data between laboratories.

Mixed Fishery Sampling and Analysis

During 1985 (11-15 July), 877 fish were sampled from a commercial troll fishery off the west coast of Vancouver Island (Southern Areas 23-24). Additionally, in 1984 (19-24 July), 326 and 731 fish were sampled from the northern (Areas 25-26) and southern (areas 21-24) West Vancouver Island fisheries , respectively, with Pacific Fishery Management Council funding. All sampling was done at the port of Ucluelet. The number of fish sampled during 1985 fell short of our goal (3,000 fish) because of a shortened season and poor catches.

Table 1.--Area, run-time, location, and origin (W=wild or H=hatchery) of chinook salmon populations sampled).

Area	Run-time	Location	Origin
Columbia and Snake Rivers	Summer	Wenatchee	W
	"	Okanogan	W
	Spring	Naches (Yakima)	W
	"	Tucannon	W
	"	Rapid River	H
	Fall	Washougal	H
	"	Lyon's Ferry	H
Oregon coastal	Spring	Cole Rivers (Rogue)	H
	"	Rock Creek (Umpqua)	H
	"	Cedar Creek (Nestucca)	H
	"	Trask	H
	Fall	Cole Rivers (Rogue)	H
	"	Elk	H
	"	Fall Creek (Alsea)	H
	"	Salmon	H
	"	Trask	H
Fraser River	Summer	Shuswap	W
	Spring	Bowron	W
	Fall	Harrison	H
British Columbia coastal	Summer	Squamish	H
	"	Bella Coola	H
		Deep Creek (Skeena)	W

Analyses of stock composition were done for both 1984 and 1985 fisheries using the. baseline data set shown in Table 2. The data set consisted of the following loci : AAT-12; AAT-3; ADA-l ; DPEP-1; GPI-1; GPI-2; GPI-3; GPI-H;4/ GR; IDH-3,4; LDH-4; LDH-5; MDH-1,2; MDH-3,4; MPI; PGK-2; TAPEP-1; and SOD-l.

The computer program used to estimate compositions of the mixed fisheries was a modified version programmed by Russell Millar, University of Washington. Changes from the program used previously resulted in improved run-time efficiency and an improved method (Infinitesimal Jacknife Procedure) for estimating variances (Millar 1986).

RESULTS AND DISCUSSION

Objective 1 – Improved Operational Efficiency Through Direct Entry of Electrophoretic Data into the Computer.

Although the GSI method has been used in ocean mixed stock fisheries for 3 years, development of its in-season potential has not been emphasized. Work accomplished under this objective has resulted in a faster method for computer entry of electrophoretic data making in-season application more practical.

Standard procedure is to record electrophoretic data with paper and pencil. These data must then be key-to-tape processed before they can be used to make estimations of fishery composition. A "rush" job (for key-to-tape processing) may require 3 days and often more. This delay is unacceptable for GSI in-season applications when quick turnabout from mixed fishery sampling to

4//GPI-H probably represents a variant allele at either GPI-1 or 3, rather than a separate locus.

Table 2.--Baseline data set used to estimate the composition of chinook salmon fisheries off the west coast of Vancouver Island.

Stock group	Location	Run time
Sacramento River	Coleman late-Nimbus	Fall
	Feather	Spring
	Feather late-Mokelumne	Fall
California coastal	Mad	Fall
	Mattole-Eel	"
	Smith	
Klamath	Iron Gate	Fall
	Trinity	"
	Trinity	Spring
Oregon coastal (Southern)	Applegate (Rogue)	Fall
	Chetco	"
	Cole Rivers (Rogue)	"
	Cole Rivers-Hoot Owl (Rogue)	Spring
	Elk	Fall
	Lobster Creek (Rogue)	"
	Pistol	"
Oregon coastal (Northern)	Cedar	Fall
	Cedar	Spring
	Coquille	Fall
	Nehalem	"
	Nestucca-Alsea	"
	Rock Creek (Umpqua)	Spring
	Salmon	Fall
	Sixes	"
	Siuslaw	"
	Trask	Spring
	Trask-Tillamook	Fall
Lower Columbia/Bonn. Pool (fall)	Cowlitz-Kalama	Fall
	Lewis	"
	Washougal	"
	Spring Creek-Big Creek	"
Lower Columbia (spring)	Cowlitz-Kalama	Spring
	Lewis	"
Willamette (Columbia)	Eagle Creek-McKenzie	Spring

Table 2.--cont.

Stock group	Location	Run time
Mid-Columbia	Carson-Leavenworth	Spring
	John Day	"
	Klickitat	"
	Nachez (Yakima)	"
	Warm Spring-Round Butte	"
	Winthrop	"
Columbia ("Bright")	Deschutes	Fall
	Ice Harbor	"
	Priest Rapids-Hanford Reach	"
	Yakima	"
Snake	Tucannon	Spring
	Rapid River-Valley Creek	"
Upper Columbia/ Snake	McCall-Johnson Creek	Summer
	Wel ls	"
	Wenatchee-Okanogan	"
Washington coastal (fall)	Hoh	Fall
	Humptulips	"
	Naselle	"
	Queets	"
	Quinault	"
	Soleduck	"
Washington coastal (spring/summer)	Soleduck	Spring
	Soleduck	Summer
Puget Sound (fall/summer)	Deschutes	Fall
	Elwha	"
	Green/Samish	"
	Hood Canal	"
	Skagit	Summer
	Skykomish	"
Puget Sound (Spring)	South Fork Nooksack	Spring
	North Fork Nooksack	"
Lower Fraser	Harrison	Fall
Mid-Fraser	Chilko	Spring
	Quesnel (white)-Quesnel (Red)	"
	Stuart-Nechako	"
Thompson (Fraser)	Clearwater	Summer
	Eagle	"
	Shuswap	"
	Shuswap via Eagle	

Table 2.--cont.

Stock group	Location	Run time
Upper Fraser	Bowron	Spring
	Tete Jaune	"
West Vancouver Island	Nitinat	Fall
	Robertson Creek	"
	San Juan	"
Georgia Strait	Big Qualicum	"
	Capilano	"
	Puntledge	"
	Quinsam	"
	Squamish	"
Central B.C. coastal	Babine	Summer
	Bella Coola	"
	Deep Creek (Skeena)	"
	Kitimat	"

estimates of composition are needed. Direct entry of electrophoretic data into a computer eliminates this problem and also eliminates errors resulting from key-to-tape processing.

The prototype computer program was tested, revised, and refined by using it in actual applications during the collection of baseline and mixed stock fishery elect rophoret ic data. The result was a program having good error checking and data correcting capabilities and excellent computer/human interface features. A write-up/program description is given in Appendix A.

Objective 2 – Expand and Strengthen Oregon Coastal and British Columbia Baseline Data Set.

Approximately 105 loci expressed through 49 enzyme systems (Table 3) were electrophoretically screened for genetic variation during the collection of baseline data for the 22 stocks listed in Table 1. Complete sets of population data were obtained for 35 polymorphic (i.e., at least one heterozygote was observed) and 19 monomorphic loci. Allele frequency data for the loci polymorphic for the 22 stocks are given in Appendix B.

An additional 30 loci were polymorphic but not resolved sufficienctly to permit cons is tent collection of data (indicated with a “P” in the variant allele column of Table 3). Resolution of these loci and their incorporation into the coastwide baseline data set will be given high priority next year, Their inclusion (and any other new genetic variation) in the data set will increase the discriminatory power of the GSI method and result in: (1) reduced sampling effort, (2) better precision, and (3) improved in-season turnaround capability.

Objective 3 - Conduct a Pilot GSI Study of Mixed Stock Canadian Troll Fisheries off the West Coast of Vancouver Island.

The GSI analyses of the 1984 and 1985 commercial troll fishery off the west coast of Vancouver Island typify the kind of information required to

Table 3.--Enzymes (Enzyme Commission number), loci, variant alleles, tissues, and buffers used. Locus abbreviations with asterisks (*) indicate loci not resolved sufficiently to consistently permit collection of reliable gentic data. Tissues: E, eye; L, liver; H, heart; and M, skeletal muscle. Buffer designation numbers correspond with those in the text.

Enzyme (E.C. number)	Locus	Varian+a/ allele	Tissue(s)	Buffers(s)b/
aconitate hydratase (4.2.1.3)	AH-l"		H,M	2
	AH-2*	P	H,M	2
	AH-3*	P	H,M	2
	AH-4	116	L	2
		108		
		86		
		69		
	AH-5*	P	H,M	2
(3-N.acetylgalactosaminidase (3.2.1.53)	bGALA-1*		L	2
	bGALA-2*		L	2,3
N-acetyl- -glucosaminidase (3.2.1.30)	bGALA-l*		L	2
acid phosphatase (3.1.3.2)	ACP-1		L,M	1,2
	ACP-2		M	1
adenosine deaminase (3.5.4.4)	ADA-l	83	E,M	1
	ADA-2	105	E,M	1
adenylate kinase (2.7.4.3)	AK-l		E,M	2
	AK-2		M	2
alanine aminotransferase (2.6.1.2)	ALAT		E	1
alcohol dehydrogenase (1.1.1.1)	ADH	-52	L	1,2
		-170	L	
aspartate aminotransferase (2.6.1.1)	AIT-l,2	105	M	1
		85		
	AAT-3	113	E	1
		90		
	AAT-4	130	L	1
		63		
	AAT-5C/		L	1
catalase (1.11.1.6)	CAT*		LH	1,3

Table 3.--Cont.

Enzyme (E.C. number)	Locus	Variant@ allele	Tissue(s)	Buffers(s)b/
creatine kinase (2.7.3.2)	CK-1*	P	M	3
	CK-2*	P	M	3
	CK-3*3/	P	E	3
	CK-4*	P	E	3
diaphorase (1.6.2.2)	DIA*	P	E	2
enolase (4.2.1.11)	ENO*		E,L,M	1,3
esterase (3.1.1.)	EST-1,2*	P	L	3a
	EST-3*	P	M	3a
	EST-4,5*	P	M	3a
	EST-6,7*	P	L	3a
fructose-biphosphate aldolase (4.1.2.13)	FBALD-l*		M	2a
	FBALD-2*		M	2a
	FBALD-3	89	E	2a
	FBALD-4	110	E	2a
		94		
fumarate hydratase (4.2.1.2)	FH	110	E,M	2
glucose-6-phosphate isomerase (5.3.1.9)	GPI-1	60	M	3
	GPI-2	135	M	3
		60		
	GPI-3	105	M	3
		93		
		85		
	GPI-H	Pc/	M	3
q-glucosidase (3.2.1.20)	aGLU-1*		L	2,3
	aGLU-2*	P	L	2,3,
8-glucyronidase (3.2.1.31)	bGUS*		L	3
glutathione reductase (1.6.4.2)	GR	110	E,M	1
		85		

Table 3.--cont.

Enzyme (E.C. number)	Locus	Variant& allele	Tissue(s)	Buffers(s)b/
glyceraldehyde-3-phosphate dehydrogenase (1.2.1.12)	GAPDH- 1		M	2a
	GAPDH-2	112	M	2a
	GAPDH-3*	P	H	2a
	GAPDH-4*	P	H	2a
	GAPDH-5		E	2a
	GAPDH-6		E	2a
glycerol-3-phosphate dehydrogenase (1.1.1.8)	G3PDH-1		M	2
	G3PDH-2		M	2
	G3PDH-3*		H	2
	G3PDH-4*		H	2
guanine deaminase (3.5.4.3)	GDA- 1*	P	E,L	1,2
	GDA-2*	P	E,L	1,2.
guanylate kinase (2.7.4.8)	GUK*		E	1
hexokinase (2.7.1.1)	HK*		L	2
hydroxyacylglutathione hydrolase (3.1.2.6)	HAGH	143	L	1
L-iditol dehydrogenase (1.1.1.14)	IDDH-1*	P	L	3a
	IDDH-2*	P	L	3a
isocitrate dehydrogenase (1.1.1.42)	IDH- 1		E,M	2
	IDH-2	154	E,M	2
	IDH-3,4	142	E,L	2
		127		
		74		
		50		
L-lactate dehydrogenase (1.1.1.27)	LDH-1		M	3
	LDH-2		M	3
	LDH-3		E,M	3
	LDH-4	134	LLM	3
		112		
		71		
	LDH-5	90	E	3
		70		
lactoylglutathione lyase (4.4.1.5)	LGL		E,M	3

Table 3.-- cont.

Enzyme (E.C. number)	Locus	Varianta/ allele	Tissue(s)	Buffers(s)b/
malate dehydrogenase (1.1.1.37)	MDH-1,2	120 27 -45	L,M	2
	MDH-3,4	121 83 70	M	2
	mMDH*		E,M	2
malate dehydrogenase (NADP) (1.1.1.40)	MDHp-l*	P	M	2
	MDHp-2*	P	L	2
	MDHp-3*	P	M	2
	MDHp-4*	P	L	2
mannose phosphate isomerase (5.3.1.8)	MPI	113 109 95	E,L	1
a-mannosidase (3.2.1.24)	aMAN	91	E,L	1
nucleoside-triphosphate pyrophosphatase (3.6.1.19)	NTP*		M	1
peptidase (glycyl-leucine) (3.4.11.0)	DPEP-1	110 90 76	E,M	1
	DPEP-2	105 70	E	1
(leucylglycylglycine)	TAPEP-1	130 68 45	E,M	3
	TAPEP-2c/		E,M	3
(leucyl-tyrosine)	PEP-LT	110	E,M	1
(phenylalanyl-proline)	PDPEP-1*		E,M	1
	PDPEP-2	107	E,M	1
(phenylalanylglycylglycyl-phenylalanine)	PGP-1*		M	1
	PGP-2*		M	1
phosphoglucomutase (2.7.5.1)	PGM- 1*	P	E,M	2
	PG?l-2*	P	E,L,M	2

Table 3.--cont.

Enzyme (E.C. number)	Locus	Variant[a/] allele	Tissue(s)	Buffers(s)[b/]
phosphogluconate dehydrogenase (1.1.1.44)	PGDH	90 85	E,L	2
phosphoglycerate kinase (2.7.2.3)	PGK-1		E,L,M	2
	PGii-2	90	E,L,M	2
purine-nucleoside phosphorylase (2.4.2.1)	PNP-1*	P	E	2
	PNP-2*	P	E	2
pyruvate kinase (2.7.1.40)	PK-1*		M	2
	PK-2*	P	E,M,H	2
superoxide dismutase (1.15.1.1)	SOD-l	1260 580 -260	L,M	1
	SOD-2*	P	M	1
triose-phosphate isomerase (5.3.1.1)	TPI-1	60 -138	E,M	3
	TPI-2		E,M	3
	TPI-3	104 96 75	E,M	3
tyrosine aminotransferase (2.6.1.5)	TAT*		L	1
xanthine oxidase (1.1.3.22)	XO*	P	L	3

[a/] Variant alleles were designated by relative homomerie mobilities, i.e., as a percentage of the mobility of an arbitrarily selected homomer, usually the most commonly occurring one. A negative designation indicates cathodal mobility. Polymorphic loci not resolved sufficiently to permit consistent determination of genotype are indicated with a "P".

[b/] These were the buffers providing the best resolution and used to deternine the relative mobilities given in the table. The ADH-52 allele is determined on Buffer 2 and the -170 allele on Buffer 1.

[c/] These loci were examined for variation based largely on the pattern of inter locus heteromeric bands.

[d/] The GPI-H polymorphism is detected by a lack of staining activity at the site of the GPI-l/GPI-3 inter locus heteromeric band.

effectively manage and accurately allocate harvests of ocean fisheries. Table 4 shows the estimated composition by stock group of the southern, northern, and total western Vancouver Island fisheries for 1984 and of the southern fishery for 1985. These data are graphically presented in Figure 1 in a condensed form to highlight differences in composition among 1985 sampling from the southern area and the northern and southern area samplings of 1984.

Columbia River and Canadian stocks were estimated to comprise approximately 60 to 70% of these fisheries. Contribution of Columbia River stocks ranged over years and areas from 25.7 to 40.7%; similarly, Canadian stocks ranged from 25.5 to 46.0%. Lower Columbia/Bonneville Pool fall run "tules,* were the major contributing stock group from the Columbia River. The major Canadian stocks contributing to the fisheries were from Fraser River and West Vancouver Island. Of the remaining stocks (collectively contributing approximately 40%), those from Puget Sound were the major contributors. As a group their contributions ranged over years and areas from 22.5 to 27.2%. Stocks other than Columbia River, Canadian, and Puget Sound contributed collectively 5 to 15% to the fisheries.

A significant difference in composition was identified between the northern and southern fisheries during 1984. Roughly twice as many (36.2 vs 18.7%) Lower Columbia River/Bonneville Pool fish were harvested in the southern area as in the northern area fishery.

Also, significant differences were observed within the southern area between years. Catch of Columbia River fish dropped from 40.7% in 1984 to

Table 4.--Estimated percentage contributions of stock groups and (in parentheses) 80% confidence intervals of West Vancouver Island troll fisheries--listed in descending order of mean estimated contribution Sample sizes : south (1984) = 731, north (1984) = 326, total (1984) = 1,103, and south (1985) = 877.

Stock group	1984 South	1984 North	1984 Total	1985 South
Lower Columbia/Bonneville Pool (Fall)	36.2 (5.2)	18.7 (5.8)	29.6 (2.9)	18.3 (3.1)
Puges Sound (fall/summer)	25.0 (6.6)	22.2 (7.1)	24.3 (3.3)	15.6 (3.2)
Lower Fraser (Harrison)	6.8 (3.1)	5.5 (3.5)	8.1 (1.8)	19.7 (3.3)
Mid Fraser (spring)	4.6 (2.0)	7.6 (4.0)	5.9 (2.1)	13.6 (2.8)
Thompson (Fraser-summer)	1.8 (3.7)	6.4(6.2)	3.8 (2.8)	8.4 (6.6)
West Vancouver Island (fall)	6.4 (15.6)	9.8 (7.1)	3.3 (4.4	0.2 (0.8)
Georgia Strait (fall)	2.2 (11.3)	3.8 (2.6)	3.7 (1.5)	3.7 (2.3)
Puget Sound (spring)	0.7 (0.9)	3.3 (3.5)	2.9 (1.7)	6.9 (3.1)
Washington coastal (spring/summer)	4.1 (19.2)	4.5 (11.1)	2.7 (3.9)	0.4 (0.6)
Upper Columbia/Snake (summer)	2.5 (4.3)	5.1 (6.6)	3.6 (2.3)	5.7 (3.0)
Oregon coastal (spring/fall)	2.8 (3.6)	6.0 (9.8)	5.2 (4.3)	2.6 (5.7)
Sacramento (spring/fall)	4.0 (11.2)	1.4 (2.6)	3.1 (2.3)	1.0 (2.1)
Other[a]	2.8 (3.8)	6.0 (5.8)	4.0 (.019)	4.1 (7.0)

a/ Inlcudes stock groups contributing individually less than 1.9 to all four fisheries: Lower Columbia River (spring), Willamette (spring), mid-Columbia (spring), Snake (spring), Columbia ("bright" fall), California coastal (fall), Klamath (spring/fall), Oregon coastal (southern-spring/fall), Washington coastal (fall), Upper Fraser (spring), and Central B.C. coastal (summer).

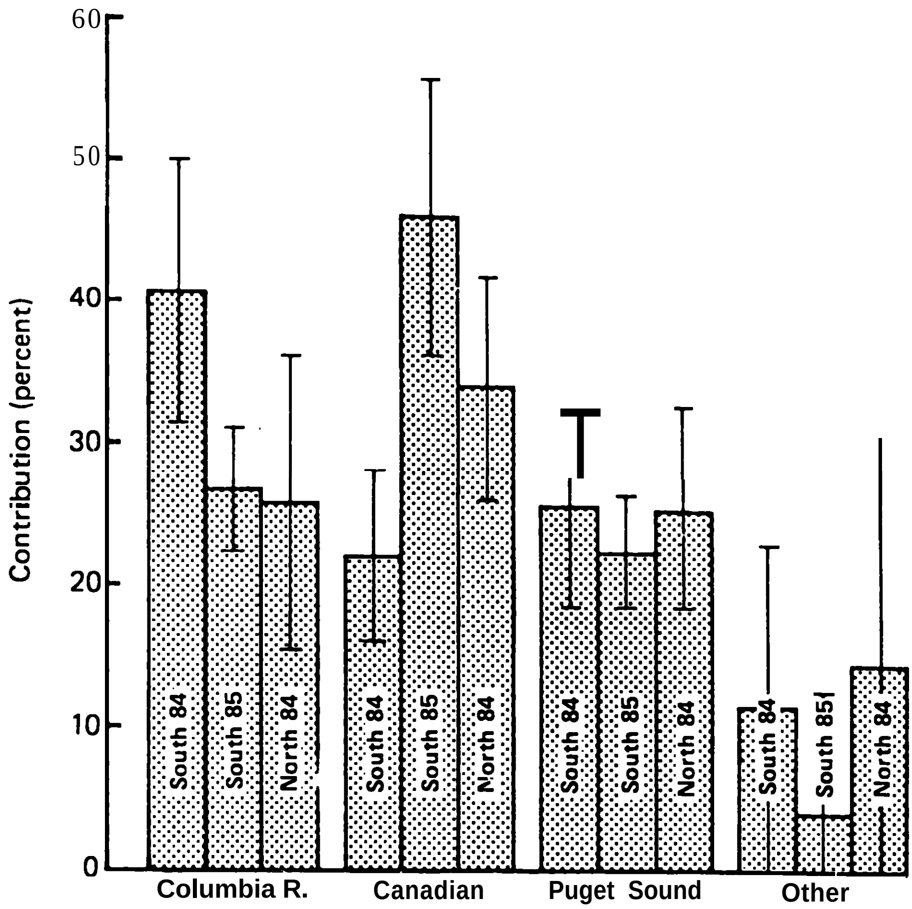

Figure 1.--Histograms (with 80% confidence intervals) summarizing estimated regional contributions of 1984 and 1985 fisheries off Vancouver Island.

26.7% in 1985. This drop was due almost entirely to reduced harvest of the Lower Columbia River/Bonneville Pool stock group. In contrast, the contribution of Canadian stocks increased significantly from 22.0 to 47.0%. Canadian stock groups contributing significantly to this increase included the lower Fraser (6.8 to 19.7%) and mid Fraser (4.6 to 13.6%). Puget Sound stock groups also contributed differently between years within the southern area fishery. Puget Sound (fall/summer) contribution decreased from 25.0 to 15.6%, while Puget Sound (spring) increased from 0.7 to 6.9%.

Data from Utter et al. (submitted) show that approximately 72 to 87% of the chinook salmon harvested in U.S. fisheries off the Washington coast and in Juan de Fuca Strait were from the Columbia River, Canadian, and Puget Sound stocks. The same groups of stocks also were the major contributors (approximately 85 to 95%) to the B.C. troll fisheries analyzed here. Utter et al. (submitted) reported substantially increasing contributions by Canadi an/Puge t Sound stocks in fisheries proceeding from the southern to northern Washington roast and into Juan de Fuca Strait. This observation was not unexpected , since the sampling areas of the northern Washington coast and Juan de Fuca Strait are located near or at the point of entry for stocks of chinook salmon destined for Puget Sound and British Columbia. One might expect a similarly large or larger contribution by these stock groups to the West Vancouver Island fisheries, and such was the case. Canadi an/Puge t Sound stocks accounted for an estimated 45 to 70% of these fisheries.

These results illustrate the usefulness of GSI for managing ocean fisheries of chinook salmon. The estimates of stock composition indicate substantial temporal and spatial variation. This kind of information can now become available within a few days of sampling a fishery. It is no longer necessary to rely soley on data derived from simulation models and other indirect methods of estimation for pre-season planning, evaluation of regulatory measures, or allocation of harvest.

Objective 4 - Validation of GSI for Estimating Mixed Fishery Stock Composition.

Credibility of GSI as a reliable tool for estimating mixed stock compositions was achieved through two Bonneville Power Administration (BPA) funded studies. A blind test in the Columbia River (Milner et al. 1981) was followed by an ocean fishery demonstration carried out cooperatively by NMFS and WDF (Milner et al. 1983; Miller et al. 1983). Coastwide application of GSI requires that all agencies have confidence in the results generated by the methodology. During FY84, ODFW, CDFG, WDF, and NMFS discussed two approaches for validating GSI: computer simulations and blind sample tests (from known origin). The agencies agreed that simulation testing was a logical first step to give fishery managers a better understanding of **how the** the GSI estimator behaves.

Computer simulations were designed to determine ocean fishery sample sizes (N) necessary to estimate contributions of individual stocks or groups of stocks with 80 or 95% confidence intervals equal to plus or minus 20% of the estimated contributions.[5/] These intervals were the criteria of precision for the estimated contributions. Northern and southern California ocean fisheries were simulated using allele frequencies of populations included in the baseline data set. Contributions of baseline stocks for the simulated

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5/ Computer program used for the simulations was written by R. Millar, University of Washington, Seattle.

mixed stock fisheries were suggested by CDFG (Tables 5 and 6). These stocks and their contributions are believed to be representative of actual northern and central California coastal commercial troll fisheries. The hypothetical fisheries were resampled 50 times for a range of sample sizes (250, 500, and 1,000 fish). Estimates of composition and empirical standard deviations (SD) of the estimates based on the 50 replications were obtained and used to establish sample sizes needed to satisfy the criteria given above.

Measurements of Accuracy and Precision

Measurements of accuracy and precision were used to evaluate the results of the simulation. Accuracy was expressed as the magnitude of the difference between actual and mean estimated contribution divided by actual contribution times 100 (i.e., percent error).

Precision was expressed in terms of a coefficient of variation, CV^n which was defined as (n x SD/mean estimated contribution) x 100, where n is the number of SD defining the area under a standard normal curve. The three values of n - 1.00, 1.28, 1.96, respectively, defined approximately 68, 80, and 95% of this area.

These measurements of accuracy and precision are used in the results and discussion that follow.

Northern California Fishery

Estimates of percent contribution to the hypothetical northern California fishery and measures of their accuracy and precision are presented graphically for 21 stocks in Figure 2 and in tabular form in Appendix C. The same kind of information is provided in Figure 3 and Appendix C for 10 management units (i.e., groupings of stocks). Accuracy and precision are summarized in Table 7

Table 5.--Hypothetical stock contributions to northern California chinook salmon fishery including three stock groupings (A, B, and C) (F = fall run, Sp = spring run).

Region Drainage system Stock	Contribution by stock combination (X) Individual stock	A	B	C
California				
Sacramento				
Feather-Nimbus (F)	20	25	25	25
Feather (Sp)	5			
Klamath				
Iron-Gate-Shasta-Scott (F)	10	23	23	23
Trinity (Sp & F)	13			
Smaller coastal rivers				
Mattole-Eel (F)	16	16	21	
Mad (F)	1	5		
Smith (F)	4 I	7		
Oregon Coast				
Small coastal rivers				
Nehalem (F)	1			
Tillanook (F)	1			
Trask (F)	1			
Siuslaw (F)	1	9	9	
Rock Creek (F)	4			
Coquille (F)	1			52
Elk (F)	1	3		
Chetco-Vinchuk (F)	2			
Rogue			19	
Cole R.-Hoot Owl (Sp)	10			
Cole R. (F)	4	16		
Lobster Ck. (F)	1			
Applegate (F)	1			
Columbia River				
Lower River				
Washougla (F)	2			
Snake River		3	3	
Rapid R. (Sp)	1 I			
Total	100	100	100	100

Table 6.--Hypothetical stock contributions to central California chinook salmon fishery including three stock groupings (A, B, and C). F = fall run; Sp = spring run.

Region Drainage System Stock	Contribution by stock combination (%) Individual stock	A	B	C
California				
Sacramento				
Feather (Sp)	11	89	89	89
Feather-Nimbus (F)	78			
Klamath				
Iron Gate-Shasta-Scott (F)	2	2	4	
Trinity (Sp & F)	2	2		8
Small coastal rivers				
Mattola-Eel (F)	3	3	4	
Mad (F)	0.5	1		
Smith (F)	0.5			
Oregon Coast				
Smaller coastal rivers				
Nehalem (F)	0.1			
Tillamook (F)	0.1			
Trask (F)	0.1			
Siuslaw (F)	0.1			
Rock Creek (F)	0.2			
Coquille (F)	0.1	2	2	2
Elk (F)	0.2			
Chetco-Winchuk (F)	0.2			
Rogue				
Cole R.-Hoot Owl (Sp)	0.2			
Cole R. (F)	0.2			
Lobster Ck. (F)	0.3			
Applegate (F)	0.2			
Columbia River				
Lower river				
Washougal (F)	0.5	1	1	1
Snake River				
Rapid R. (Sp)	0.5			
Total	100	100	100	100

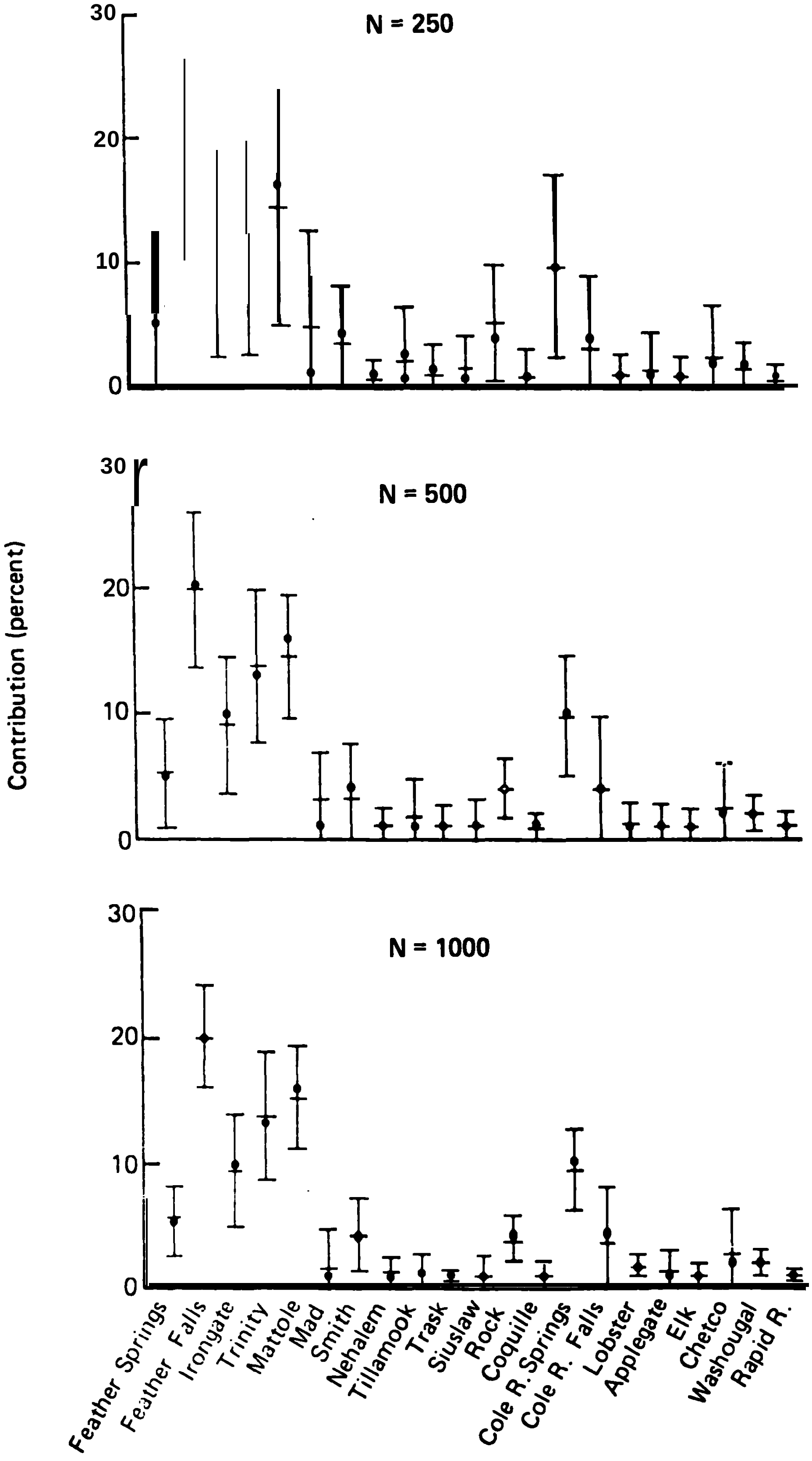

Figure 2.--Actual (circles) and mean estimated (1.28 SD) contributions of 21 stocks from samples of 250, 500, and 1,000 individuals from a simulated northern California fishery.

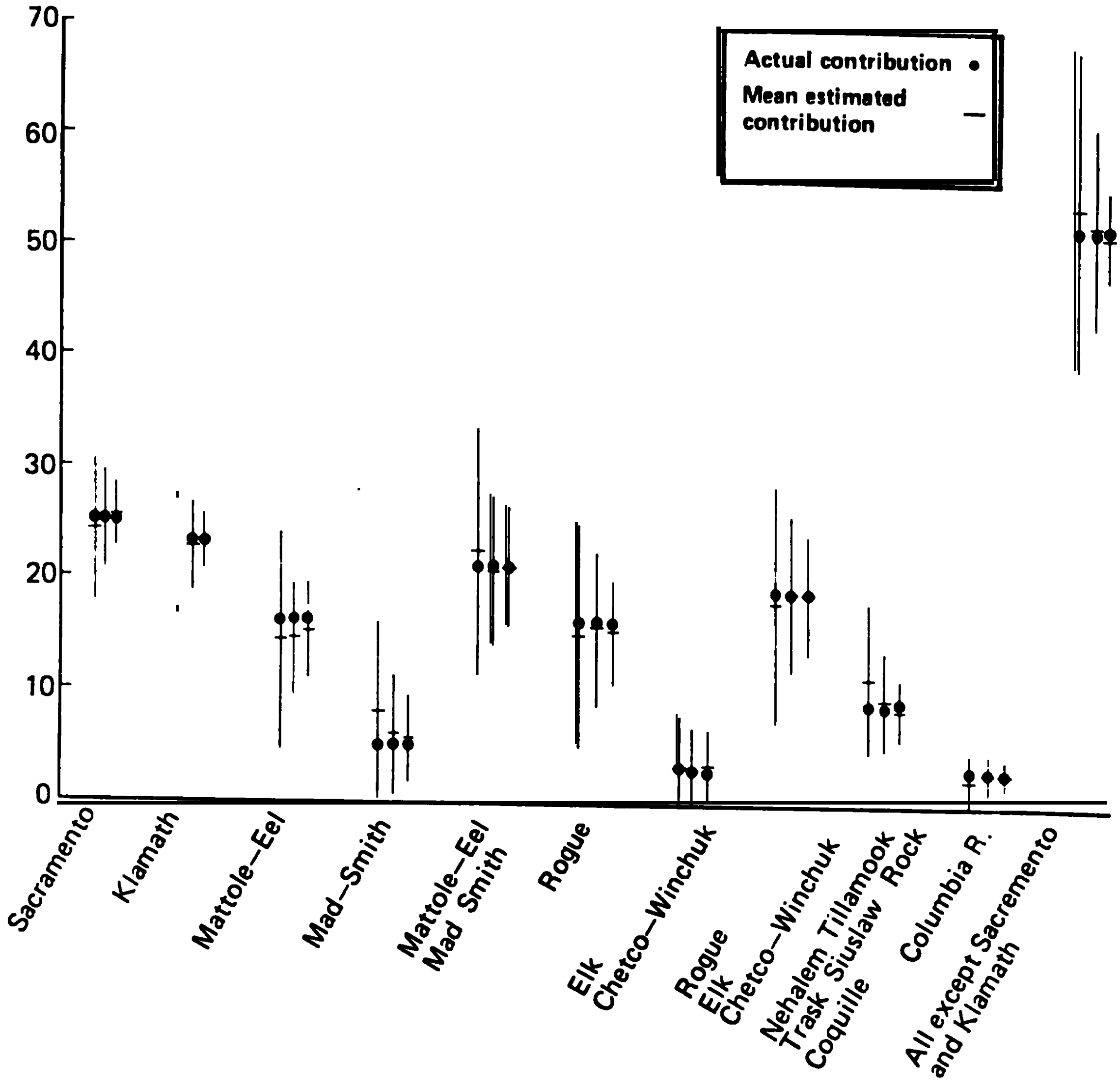

Figure 3.--Actual and mean estimated (1.28 SD) contributions of 11 management units from samples of 250, 500, and 1,000 individu from a simulated central California fishery.

Table 7.--Summary of accuracy and precision for estimates of stock composition from samples of 250, 500, and 1,000 in a simulated northern California fishery.

	No. of observations	Accuracy and precision by sample size (N)		
		N = 250	N = 500	N = 1,000
		Accuracy (% error)		
Individual stocks	21	38.7 (3.5-375.0)	20.1 0.7-214.0)	12.5 (0.6-72.0)
Contribution > 5%	5	9.7 (3.5-14.8)	5.8 (0.9-9.9)	4.8 (0.6-6.5)
Contribution ≤ 5%	16	47.8 (5.0-375.0)	24.5 (0.7-214.0)	14.9 (2.3-72.0)
Stock Groups	11	14.6 (4.0-62.2)	5.2 (0.0-24.2)	5.0 0.1-20.0)
Contribution > 5%	8	8.4 (4.0-25.7)	2.6 0.0-9.7)	2.3 0.1-5.1)
Contribution ≤ 5%	3	31.1 (6.0-62.2)	12.2 2.3-24.2)	12.4 1.o-20.0)
		Precision (1.28 SD/estimate x 100)		
Individual stocks	21	148.4 (49.3-225.4)	114.8 (31.2-206.9)	95.5 (20.1-168.0)
Contribution > 5%	5	69.8 (49.3-79.0)	43.5 31.2-60.3)	34.3 (20.1-49.8)
Contribution ≤ 5%	16	173.0 89.8-225.4)	137.1 (57.6-206.9)	114.7 (45.9-168.0)
Stock groups	11	66.1 (24.9-146.5)	45.9 (17.4-116.4)	34.1 10.3-89.7)
Contribution > 5%	8	47 .o (24.9-66.8)	30.4 (17.4-44.8)	22.0 (10.3-31.6)
Contribution ≤ 5%	3	116.9 (96.3-146.5)	87.0 (57.7-116.4)	66.6 (43.2-89.7)

by averaging them over individual stocks, stock groups, and stocks or stock groups contributing over, less than, or equal to 5%.

Both accuracy and precision improved as mixed fishery sample sizes increased from 250 to 1,000 fish. Thus, for example, average accuracy of the estimates for 21 stocks increased from 38.7% (N = 250) to 12.5% (N = 1,000); similarly, precision ($CV^{1.28}$) increased from 148.4 to 95.5 (Table 7). The same trend was observed for the pooled stock groupings and for the comparisons of stocks or stock groups contributing over, less than, or equal to 5%.

Accuracy and precision were better for those stocks or stock groups contributing over 5% to the fishery. Thus, at a mixed fishery sample size of 1,000 fish, the average percent error for components contributing over 5% was 4.8 and 2.3% for individual stocks and stock groups, respectively, whereas average percent error for components contributing less than or equal to 5% was 14.9 and 12.4%. Precision behaved in a similar manner. The average $CV^{1.28}$ for components contributing over 5% was 34.3 (individual stocks) and 22.0 (stock groups), contrasted with 114.7 and 66.6 for components contributing less than 01 equal to 5%.

Finally, average accuracy and precision were better for stock groupings than for individual stocks. For example, with N = 1,000, average accuracy increased 60% (from 12.5 to 5%) and precision increased 64% (from 95.5 to 34.1 $CV^{1.28}$).

Precision of estimates satisfying the less severe of the two criteria stated earlier (i.e., $CV1.28 \leq 20$) was obtained with N = 500 fish for three stock groupings: Klamath, Sacramento, and a group consisting of all stocks except Klamath and Sacramento (Table 8). These criteria were also met with N = 1,000 fish for the Feather-Nimbus fall run stock. Estimates for the same

Table R.--Management units having CV^{n} (n = 1.00, 1.28 and 1.96) less than or equal to 39.9 for sample sizes 250, 500, and 1,000 fish (northern California simulated mixed stock fishery).

Management unit	Estimated[a/] contribution	Coefficient of variation								
		N = 250			N = 500			N = 1,000		
		1.00 SD	1.28 SD	1.96 SD	1.00 SD	1.28 SD	1.96 SD	1.00 SD	1.28 SD	1.96 SD
Klamath	22.6	19.4	24.9	38.1	13.R	17.7	27.1	8.1	10.3	15.Y
Sacramento	24.8	20.5	26.2		13.8	17.7	27.0	8.5	10.8	16.6
All except Sacramento and Klamath	52.6	20.7	26.5		13.6	17.4	26.6	10.0	12.8	19.6
Feather-Nimbus (F)	19.2	38.5			24.4	31.2		15.7	20.1	30.8
Mattole, Had, Smith	21.3	38.6			25.2	32.3		19.6	25.1	38.4
Mattole	14.6				26.1	33.3		21.4	27.4	
Rogue, Elk, Chetco	18.7				29.1	37.2		21.9	28.0	
Rogue	15.3				33.7			23.3	29.8	
Nehalem, et al.	9.8				35.0			24.7	31.6	
Hoot Owl-Cole River	9.6				37.8			28.6	36.6	
Trinity (F & Sp)	12.9				34.6			29.4	37.5	
Columbia River	2.8							33.7		
Umpqua	4.3	-	-	-	-			35.8		
Washougal	1.9	-	-	-	-			36.1		
Irongate-Shasta-Scott	9.7	-	-	-	-			39.0		

a/ Mean (50 samples) estimated contribution averaged over 3 sample sizes.

three stock groupings also satisfied the most severe criterion ($CV^{1.96} \leq 20$) with N = 1,000 fish. None of the estimates for individual stocks met the most severe criterion at the sample sizes used in the simulation. Obviously, sample sizes larger than 1,000 fish are necessary if one is to satisfy either of the two criteria for all stocks and stock groupings.

Sample sizes needed to fulfill either of the two criteria can be calculated using the preceding results because increasing sample size by a factor, f, will reduce the SD on the average by a factor of $1/\sqrt{f}$. Thus, to obtain either a $CV^{1.28}$ or a $CV^{1.96} \leq 20$ for the stock having the highest coefficient of variation, f values of 2.89 and 3.56 were necessary (with respect to N = 1,000 fish). These values translate into mixed fishery sample sizes of 2,890 and 3,560 fish required to satisfy the original criteria of 80 and 95% confidence intervals, respectively, for all stocks and stock groupings. If one considers only the stock groupings, sample sizes of 2,320 and 2,869 fish would be necessary to meet these criteria.

Central California Fishery

Estimates of percent contribution to the hypothetical central California fishery and measures of their accuracy and precision are presented graphically for 21 stocks in Figure 4 and in tabular form in Appendix D. The same kind of information is provided in Figure 5 and Appendix D for management units (i.e., groupings of stocks) ; 10 groupings are identified in Figure 5 and seven in Appendix D. Accuracy and precision are summarized in Table 9 by averaging them over individual stocks, stock groups, and stocks or stock groups contributing over, less than, or equal to 5%.

Both accuracy and precision improved in all groupings as mixed fishery sample size increased from 250 to 1,000 fish. Thus, for example, average

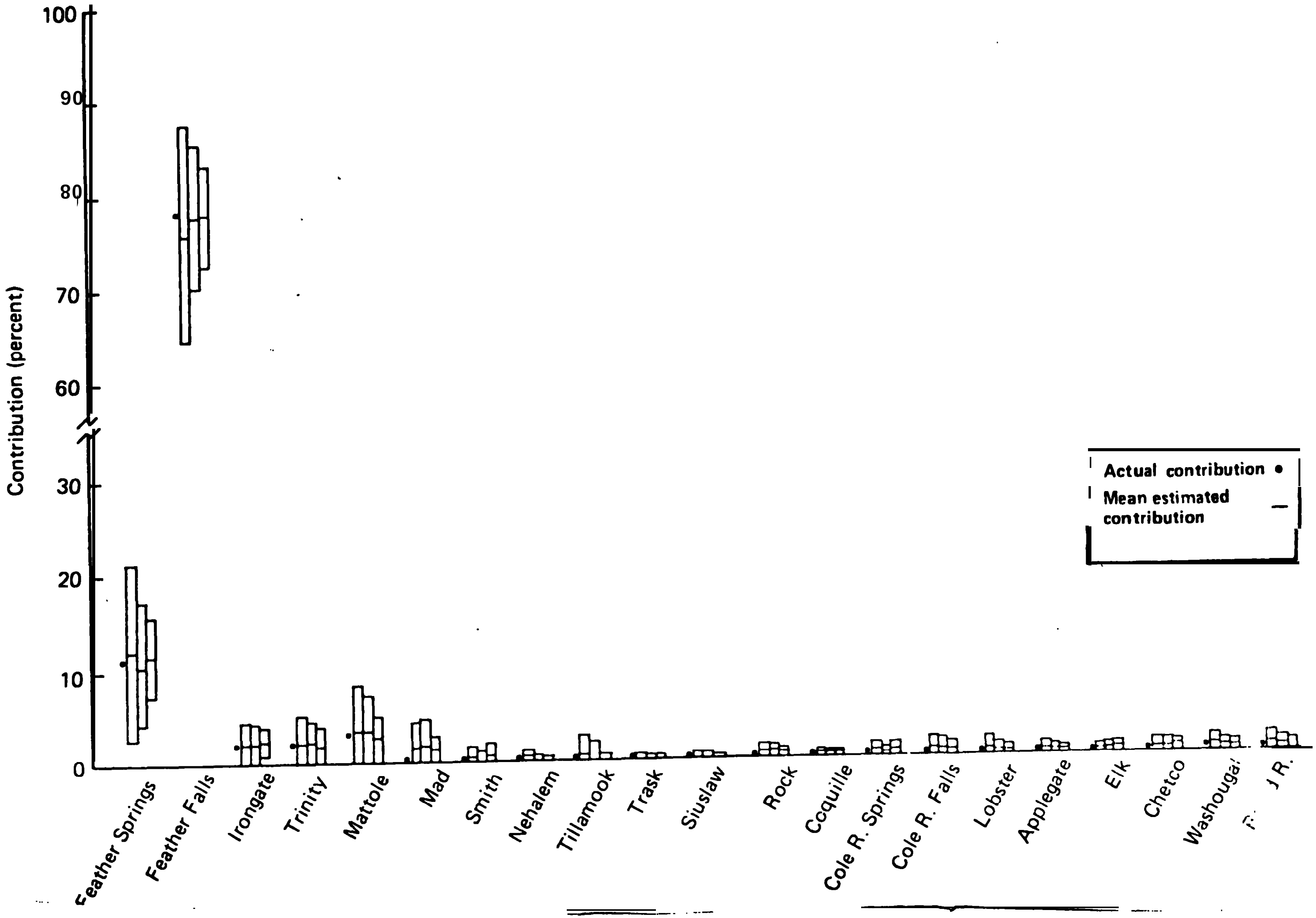

Figure 4. Actual and mean estimated (1.28 SD) contributions of 21 stocks from samples of 250, 500, and 1,000 individuals from a simulated central California fishery.

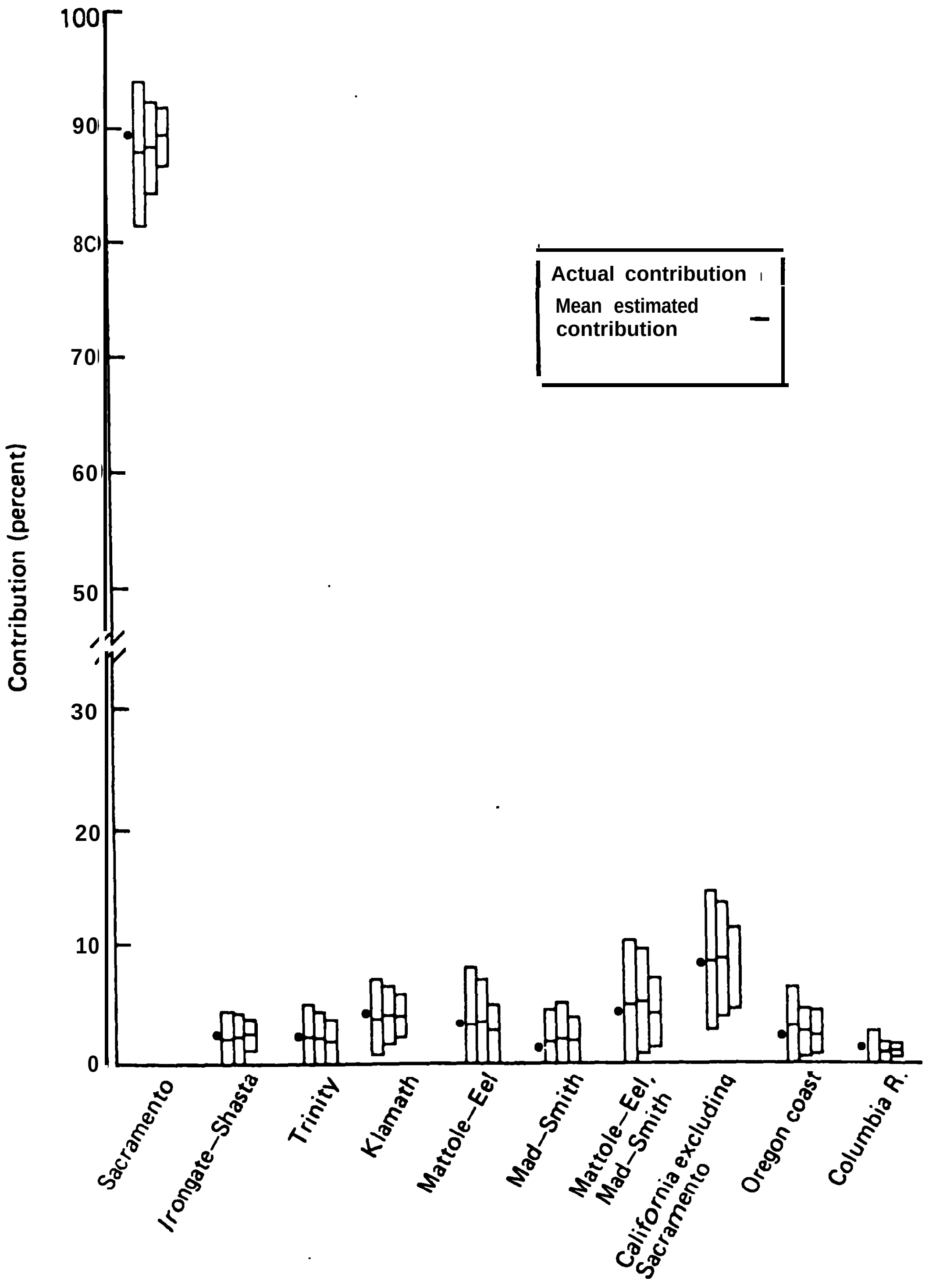

Figure 5. Actual and mean estimated (1.28 SD) contributions of 10 management units from samples of 250, 500, and 1,000 individuals from a simulated northern California fishery.

Table 9.--Summary of accuracy and precision for estimates of stock composition from samples of 250, 500, and 1,000 in a simulated central California fishery.

	No. of observations	Accuracy and precision by sample size (N)		
		N = 250	N = 500	N = 1,000
		Accuracy (% error)		
Individual stocks	21	54.4 (0.0-440.0	49.9 (0.0-270.0)	32.4 (O-0-134.0)
Contribution > 5%	2	5.0 (2.9-7.2)	2.8 0.5-5.1)	1.5 0.4-2.6)
Contribution ≤ 5%	19	59.6 (0.0-440.0)	54.9 (0.0-270.0)	35.7 (0.0-134.0)
Stock groups	7	21.4 (1 .O-65.0)	23.5 1.1-70.0)	14.5 0.0-70.0)
Contribution > 5%	2	4.1 (1.7-6.5)	5.0 (1.1-8.9)	0.5 0.0-1.0)
Contribution ≤ 5%	5	28.31 (1 .O-65.0)	30.8 1.1-70.0)	20.1 0.0-70.0)
		Precision (1.28 SD/Est. x 100)		
Individual stocks	21	287.8 15.1-522.7)	237.5 9.7-422.4)	189.4 6.8-358.4)
Contribution > 5%	2	46.8 (15.1-78.5)	36.1 9.7-62.4)	22.1 (6.8-37.3)
Contribution ≤ 5%	19	313.2 (133.0-522.7	258.5 (112.3-422.4)	207 .O 64.9-358.4)
Stock groups	7	101.4 (7.2-170.7)	83.9 4.6-187.5)	61.3 (3.0-l 19.7)
Contribution > 5%	2	38.9 (7.2-70.5)	30.6 4.6-56.6)	23.1 (3.0-43.2)
Contribution ≤ 5%	5	126.4 (86.1-170.7)	105.3 65.3-187.5)	76.6 49.4-119.7)

accuracy of the estimates for 21 stocks increased from 54.4 (N = 250) to 32.4% (N = 1,000), and similarly, precision increased from 287.8 to 189.4 $CV^{1.28}$ (Table 8).

Accuracy and precision was also better for those stocks or stock groups contributing over 5% to the fishery. For example, at a mixed fishery sample size of 1,000 fish, the average percent error for components contributing over 5% was 1.5 and 0.5% for individual stocks and stock groups, respectively, whereas average percent error for components contributing less than or equal to 5% was 35.7 and 20.1%. Precision behaved in a similar manner. The average $CV^{1.28}$ for components contributing over 5% was 22.1 (individual stocks) and 23.1 (stocks groups), whereas, for components contributing less than or equal to 5 % it was 207.0 and 76.6.

Finally, average accuracy and precision were better for stock groupings than for individual stocks. For example, with N 5 1,000, average accuracy increased 55% and precision increased 68%.

Precision of estimates satisfying both criteria ($CV^{1.28}$ and $CV^{1.96} \leq 20$) was obtained with N = 250 fish for the Sacramento group and for the Feather-Nimbus fall run stock of the Sacramento group (Table 10). None of the other estimates for individual stocks or groups of stocks satisfied either of the criteria with the sample sizes used.

Obviously, as was the case for the northern fishery, samples sizes larger than 1,000 fish are necessary if one is to satisfy either of the two criteria for all stocks and stock groupings, To obtain $CV^{1.28}$ and $CV^{1.96} \leq 20$ for the stock with the highest coefficient of variation (with respect to N = 1,000 fish), mixed fishery sample sizes of 4,160 and 5,150 fish would be necessary to satisfy these criteria for all stocks and stock groupings. If one

Table 10.--Management units having CV^n (n = 1.00, 1.28, and 1.96) less than or equal to 39.9 for sample sizes (N) of 250, 500 and 1,000 fish (central California simulated mixed stock fishery).

Management unit	Estimated contribution	Coefficient of variation								
		N = 250			N = 500			N = 1,000		
		1.00 SD	1.28 SD	1.96 SD	1.00 SD	1.28 SD	1.96 SD	1.00 SD	1.28 SD	1.96 SD
Feather-Spr.	11.2							29.1	37.3	
Feather-Nimbus (F)	77.0	11.8	15.1	23.2	7.6	9.7	14.9	5.3	6.8	10.4
Sacramento	88.2	5.6	7.2	11.0	3.6	4.6	7.1	2.4	3.0	4.6

considers only the seven stock groupings, sample sizes of 2,450 and 3,030 fish would be necessary.

Final Word on Accuracy and Precision

Accuracy and precision of estimates of composition will differ from one mixed fishery to another, even if identical sample sizes are used, unless their compositions are very similar. This source of variation becomes apparent in comparisons of the results of the two simulations. Examination of the accuracy and precision of the mean estimates of contribution of the Feather-Nimbus fall run stock and the Klamath stock group to the two simulated fisheries will suffice to illustrate this point. The Feather-Nimbus' actual contributions to the northern and central California fisheries were 20 and 78%) respectively; and the percent error and $CV^{1.28}$ were 0.65 and 20.1 vs -0.40 and 6.8, respectively, with N - 1,000 fish (Appendixes C and D) . Similarly, the Klamath group's actual contributions to the northern and central fisheries were 23 and 4X, and the percent error and $CV^{1.28}$ for N = 1,000 fish were 0.48 and 10.3 in the northern fishery vs -4.75 and 43.4 in the central f lshery. Generally, then, accuracy and precision for a particular stock or group of stocks increases as Its contribution to a fishery increases. This is an important consideration in planning and construction of sampling regimes designed to answer specific questions concerning a specific fishery.

CONCLUSIONS

These studies represent part of an integrated effort of many agencies to refine and update a GSI program that is presently being effectively used to estimate compositions of stock mixtures of chinook salmon from British Columbia southward. During the period represented by this report, our own efforts were complemented by expansions of the data base and analyses of stock mixtures carried out by groups of the Washington Department of Fisheries and the University of California at Davis. In addition, necessary assistance in sample collection was provided by personnel of California Department of Fish and Game, Oregon Department of Fisheries and Wildlife, Oregon State University, Washington Department of Fisheries, Canadian Department of Fisheries and Oceans, and the National Marine Fisheries Service. These collaborations will continue and broaden in the future as applications of GSI extend northward for chinook salmon, and involve other species of anadromous salmonids.

The value of GSI as a research and management tool for anadromous salmonids is no longer in question. Its accellerated recognition and use amply testify to its current value (Fournier et al. 1984, Beacham et al. 1985a, 1985b, Pella and Milner in press). Emphasis for a particular species and region can increasingly shift from accumulation of an adequate data base towards examinations of stock mixtures up to a certain point. Our present emphasis is roughly 50% towards both activities contrasted with an initial effort of greater than 80% towards gathering a useable data base. We ultimately envision as much as 75% of the total effort going towards mixed stock identification. The simulation process, as carried out In this report, is seen as a necessary preliminary phase preceding any large scale sampling of mixed stock fisheries to determine sampling efforts required for given levels of precision. This leaves a 25% continuing effort towards data base development, even with the existence of a data base that provides precise and accurate estimates for a particular fishery.

This continued effort is needed for two important reasons. First, the existing allele frequency data require periodic monitoring for consistencies among year classes and generations. Such consistency has been generally noted for anadromous salmonids (e.g., Utter al. 1980, Grant et al. 1980, Milner et al. 1980, Capmpton and Utter in press), but some statistically significant shifts in allele frequenciesfor a particular locus have occasionally been observed (Milner et al. 1980). These shifts are interpreted as predominantly a reflection of strayings resulting from transplantations and alterations of migrational processes (although the possibility of selection cannot be excluded) . Periodic monitoring of allele frequencies from the existing baseline populations (particularly those that would be most strongly affected by such strayings) is thereforerequired to assure continuation of accurate GSI estimates from stock mixtures.

Secondly,even an effective set of baseline data for a particular fishery can beimproved--sometimes dramatically--as additional genetic information is obtained. An increase in the number of informative genetic variants provides a corresponding increase in the precision ofGSI estimates of stock mixtures (e.g., Milner et al. 1980). Our research is presently focusing on increasing the number of polymorphic loci detected by electrophoresis, and has recently expanded to a search for complementary mitochondrial and nuclear DNA variation.

GSI estimates, then, continue to improve beyond an initially useful point as more and more genetic information is added to the existing baseline data. A major mission of our activity in development and application of GSI to stock mixtures will continue to be identifying additional useful genetic variations.

ACKNOWLEDGMENTS

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APPENDIX A

Description of Electrophoretic Data Entry Program (EDEP)

ELECTROPHORETIC DATA ENTRY PROGRAM (EDEP)

Purpose

Prior to the development of EDEP,electrophoretlc data from our laboratory were handled in a two-step process. They were first recorded on paper in the laboratory. Then, at some later date, they were sent out to key punch operators for entry into the computer. With EDEP, electrophoretic data are entered directly into the computer via keyboards in the laboratory. With EDEP, data can be statistically analyzed the same day they are collected.

What Does It Do

This program enables you to record phenotypes into a computer (EDEP) file locus by locus for up to 144 loci, Laboratory notes or comments may be added for each locus. It keeps a library of the files you have created in this program, the populations that are on each file, and the loci that have been entered for each population.

How Does It Work

The program is made up of four areas or menus:

I. FILEMENU - Select the EDEP data file

II. POPULATION MENU - Select the desired population

III. LOCUS MENU - Select a locus

IV. SCORING MENU - Select how you want to enter the phenotypes

Each menu lists options of various things you can do with files, populations, and loci. The options are in abbreviated form to speed up the data entry process.

Pow To Enter Data

Electrophoretic phenotypes are entered as two-digit numbers. Each digit for an individual represents a dose of an allele. Each allele of a locus is assigned a unique number. The most common allele is represented by the number "1" Therefore, the numeric value for a homozygous individual expressing the most common allele for a locus would be "11", a heterozygous individual expressing the 1 and 2 alleles would be "12", and a homozygous, individual for the 2 allele would be "22". Isoloci are entered as two separate loci.

File Menu

Create EDEP file	Asks for file name to which phenotypic data will be entered. Following <CR), the POPULATION MENU will be displayed. The name of the newly created data file Will be placed in the file GENETICS/FILENAMES for future reference. If you have entered this option by mistake, enter "MENU <CR>" to return to the FILE MENU.
Add to EDEP file	Asks for the name of an EDEP file previously created by this program to which phenotypic data for existing or new populations can be entered. Following <CR> the POPULATION MENU will be displayed. If you have entered this option by mistake, enter "0" to return to the FILE MENU.
List EDEP file names	Lists all EDEP file names created by this program. Following <CR> the FILE MENU will be displayed.

Delete name of EDEP file	Asks for the name of the EDEP file created by this program to be deleted from an EDEP library of names. Only the name of the EDEP file will be deleted from the name file. The EDEP file with phenotypic data will NOT be deleted. Following <CR> it will ask again if you are sure you wish to delete this ” ” file name. You are asked to enter "YES" or "NO" followed by <CR> aft er which the FILE MENU will be displayed. If you have entered this option by mistake, enter "MENU <CR>*' to return to the FILE MENU.
Generate raw data file	Asks for the name of an EDEP file created by this program. Following <CR> the phenotypic data on the EDEP file is written into a RAW data file which is suitable for statistical analysis. The raw data file is formatted with six lines (or records) per individual. Data for up to 144 loci are possible with 24 loci on each record. The locus order is given in the LOCUS MENU (Option 4). The population ID number will follow each line. Upon completion of this job, the FILE MENU will be displayed. If you have entered this option by mistake, enter "0" to return to the FILE MENU.
Help	Gives you background information about this program followed by a listing of the 4 menus which you access by entering the number preceeding the menu for which you need HELP. An explanation of each option is given for each menu. Following <CR> the FILE MENU will be displayed.
Quit	You exit this program.
File menu	Displays full FILE MENU

Population Menu

Enter new population	Asks for: (1) the full population name, (2) an abbreviated name, (which should include the starting sample number), (3) the starting sample number, and (4) the number of samples in this population up to 50 samples at a time. Following each response with <CR>, you will then be asked to check the population information and choose whether you wish to reenter this information (1), or accept it as listed (2). if you choose to reenter, the above questions will be repeated. If you accept the population information as listed the LOCUS MENU will be displayed. If you entered this opt Ion by mistake, enter "MENU <CR>" to return to the POPULATION MENU.
Add to an existing population	A 11 sting of population names on this file will be given which you access by entering the number preceeding the desired population. Following <CR> the LOCUS MENU will be displayed. If you entered this option by mistake, enter "0" to return to the POPULATION MENU.
List population names	Lists the population information (full name, abbreviated name, starting sample number number of samples for the population, and population ID numbers) for all the populations on the EDEP file. Following <CR> the POPULATION MENU will be displayed.
Add ID numbers to exis ting populations	Asks for the abbreviated name and the identification number for that population, which can include a species code, a population location code, age class code, and the date of collection. Eighteen (18) digits must be entered. Following each response with <CR>, you will then be asked to check the ID number with the population information and choose whether you wish to reenter the ID number (1), or accept it as listed (2). If you choose to reenter, the question? will be repeated. If you accept the ID number as listed the POPULATION MENU will be displayed. If you entered this option by mistake, enter "0" when promopted for the population abbreviation.

View locus comments	Asks if you wish to view the comments for a single locus (1) or for all the loci in this population (2). After entering the number preceeding your choice, you are asked if you wish the comments to be directed to the screen (1), to the printer (2), or to both (3). If you choose to view the comments of a single locus, you are asked the name of the locus. After viewing, enter <CR> to display LOCUS MENU. If you entered this option by mistake, enter "MENU <CR>" to return to the LOCUS MENU.
Print all locus data	Prints out all the data entered for the population in alphabetical order. Each locus is given in rows of 10 samples with 2 loci printed across the page. Population information is included. Upon completion, enter <CR> to display the LOCUS MENU.
Go to POPULATION MENU	The POPULATION MENU will be listed.
LOCUS MENU	Displays the full LOCUS MENU

Scoring Menu

Individual forward	Asks for the starting sample number where you wish to begin scoring. Then it prompts you one increasing sample number at a time, while you enter 2-digit phenotypes, until you enter another scoring option or reach the last sample number, at which time the SCORING MENU will be displayed.
Individual backward	Asks for the starting sample number where you wish to begin scoring. Then it prompts you one decreasing sample number at a time, while you enter 2-digit phenotypes, until you enter another scoring option or reach the first sample number, at which time the SCORING MENU will be displayed.
Phenotypes	Asks you to enter a phenotype, then a single sample number or group of sample numbers (groups of numbers are separated by a dash, e.g., "9-15 <CR>") which have this phenotype. Enter "M<CR), to display the SCORING MENU, or any other scoring option to get out of the PHENOTYPES option.

List data	Lists the data for this locus and displays the SCORING MENU.
Comments	Presents a Comments menu with options to add, insert, delete, or list lines. Allows an asterisks(*) to be placed by important data.
Select individual and phenotype	Asks you to enter a sample number, then a phenotype. Enter "M" <CR>" to display the SCORING MENU, or any other option to get out of the SELECT option.
List menu	Lists the SCORING MENU
Finished locus	The data from a locus are saved automatically, you are then prompted to enter another locus or return to the LOCUS MENU.
SCORING MENU	Displays full SCORING MENU.

APPENDIX B

Allele Frequencies of 27 Polymorphic Loci for
22 Stocks of Chinook Salmon
(Sample Sizes Refer to Number of Alleles)

LOCUS: AAT4

POPULATION	RUN	N	ALLELE FREQUENCIES 100	130	63		
WENATCHEE	SU	84	1.00	0.00	0.00	0.00	0.00
OKANOGAN	SU	94	0.99	0.00	0.01	0.00	0.00
NACHES	SP	70	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	84	0.92	0.00	0.08	0.00	0.00
RAPID RIVER	SP	92	0.97	0.00	0.03	0.00	0.00
WASHOUGAL	F	200	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	148	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	SP	0	0.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	198	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	170	0.98	0.02	0.00	0.00	0.00
TRASK	SP	180	0.99	0.01	0.00	0.00	0.00
COLE RIVERS	F	166	0.99	0.01	0.00	0.00	0.00
ELK	F	196	0.82	0.18	0.01	0.00	0.00
FALL CREEK	F	174	0.95	0.05	0.00	0.00	0.00
SALMON	F	188	0.92	0.08	0.00	0.00	0.00
TRASK	F	174	0.92	0.08	0.00	0.00	0.00
SHUSWAP	SU	64	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	264	0.56	0.00	0.44	0.00	0.00
HARRISON	F	194	0.98	0.00	0.02	0.00	0.00
SQUAMISH	SU	166	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	SU	94	0.93	0.00	0.07	0.00	0.00
DEEP CREEK	SU	86	0.88	0.01	0.11	0.00	0.00

LOCUS: AAT4

POPULATION	RUN	N	ALLELE FREQUENCIES 100	130	63		
WENATCHEE	SU	84	1.00	0.00	0.00	0.00	0.00
OKANOGAN	SU	94	0.99	0.00	0.01	0.00	0.00
NACHES	SP	70	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	84	0.72	0.00	0.08	0.00	0.00
RAPID RIVER	SP	92	0.97	0.00	0.03	0.00	0.00
WASHOUGAL	F	200	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	148	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	SP	0	0.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	198	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	170	0.98	0.02	0.00	0.00	0.00
TRASK	SP	180	0.99	0.01	0.00	0.00	0.00
COLE RIVERS	F	166	0.99	0.01	0.00	0.00	0.00
ELK	F	196	0.82	0.18	0.01	0.00	0.00
FALL CREEK	F	174	0.95	0.05	0.00	0.00	0.00
SALMON	F	188	0.92	0.08	0.00	0.00	0.00
TRASK	F	174	0.92	0.08	0.00	0.00	0.00
SHUSWAP	SU	64	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	264	0.56	0.00	0.44	0.00	0.00
HARRISON	F	194	0.98	0.00	0.02	0.00	0.00
SQUAMISH	SU	166	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	SU	94	0.93	0.00	0.07	0.00	0.00
DEEP CREEK	SU	86	0.88	0.01	0.11	0.00	0.00

LOCUS: ADA1

POPULATION	RUN	N	ALLELE FREQUENCIES 100	83			
WENATCHEE	SU	100	0.99	0.01	0.00	0.00	0.00
OKANOGAN	SU	100	1.00	0.00	0.00	0.00	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	200	0.96	0.04	0.00	0.00	0.00
RAPID RIVER	SP	200	1.00	0.01	0.00	0.00	0.00
WASHOUGAL	F	200	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	SP	80	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
TRASK	SP	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	200	1.00	0.00	0.00	0.00	0.00
ELK	F	200	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	0.97	0.03	0.00	0.00	0.00
SALMON	F	200	0.99	0.02	0.00	0.00	0.00
TRASK	F	200	0.94	0.06	0.00	0.00	0.00
SHUSWAP	SU	298	0.99	0.01	0.00	0.00	0.00
BOWRON	SP	300	0.86	0.14	0.00	0.00	0.00
HARRISON	F	298	0.89	0.11	0.00	0.00	0.00
SQUAMISH	SU	300	0.97	0.03	0.00	0.00	0.00
BELLA COOLA	SU	298	0.93	0.07	0.00	0.00	0.00
DEEP CREEK	SU	300	1.00	0.00	0.00	0.00	0.00

LOCUS: ADA2

POPULATION	RUN	N	ALLELE FREQUENCIES 100	105			
WENATCHEE	SU	98	1.00	0.00	0.00	0.00	0.00
OKANOGAN	SU	100	1.00	0.00	0.00	0.00	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	200	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	200	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	200	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	SP	80	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
TRASK	SP	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	200	1.00	0.00	0.00	0.00	0.00
ELK	F	200	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	200	1.00	0.00	0.00	0.00	0.00
SHUSWAP	SU	300	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	300	1.00	0.00	0.00	0.00	0.00
HARRISON	F	300	0.98	0.02	0.00	0.00	0.00
SQUAMISH	SU	300	0.96	0.04	0.00	0.00	0.00
BELLA COOLA	SU	298	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	SU	300	1.00	0.00	0.00	0.00	0.00

LOCUS : ADH

POPULATION	RUN	N	ALLELE FREQUENCIES -100	-52	-170		
WENATCHEE	su	100	1.00	0.00	0.00	0.00	0.00
OKANOGAN	su	98	0.99	0.01	0.00	0.00	0.00
NACHES	SF	100	0.90	0.02	0.00	0.00	0.00
TUCANNON	SF	200	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SF	200	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	198	0.91	0.09	0.00	0.00	0.00
LYONS FERRY	F	198	0.94	0.06	0.00	0.00	0.00
COLE RIVERS	SF	100	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SF	190	0.98	0.02	0.00	0.00	0.00
CEDAR CREEK	SP	198	1.00	0.00	0.00	0.00	0.00
TRASK	SF	192	0.99	0.01	0.00	0.00	0.00
COLE RIVERS	F	200	1.00	0.00	0.00	0.00	0.00
ELK	F	200	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	198	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	200	1.00	0.00	0.00	0.00	0.00
SHUSWAP	su	290	1.00	0.00	0.00	0.00	0.00
BOWRON	SF	298	1.00	0.00	0.00	0.00	0.00
HARRISON	F	294	1.00	0.00	0.00	0.00	0.00
SQUAMISH	SU	300	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	su	198	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	su	296	1.00	0.00	0.00	0.00	0.00

LOCUS : At-14

POPULATION	RUN	N	ALLELE FREQUENCIES 100	86	116	108	69
WENATCHEE	SU	78	0.83	0.17	0.00	0.00	0.00
OKANOGAN	SU	100	0.75	0.24	0.00	0.01	0.00
NACHES	SF	74	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	190	0.97	0.03	0.00	0.00	0.00
RAPID RIVER	SF	196	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	200	0.00	0.10	0.02	0.01	0.00
LYONS FERRY	F	198	0.89	0.07	0.02	0.00	0.00
COLE RIVERS	SP	74	0.97	0.03	0.00	0.00	0.00
ROCK CREEK	SF	198	0.74	0.04	0.03	0.00	0.00
CEDAR CREEK	SF	200	0.78	0.10	0.00	0.00	0.13
TRASK	SF	200	0.72	0.05	0.02	0.00	0.22
COLE RIVERS	F	196	0.96	0.04	0.01	0.00	0.00
ELK	F	170	0.08	0.11	0.01	0.00	0.00
FALL CREEK	F	198	0.81	0.11	0.08	0.00	0.00
SALMON	F	200	0.85	0.05	0.08	0.03	0.00
TRASK	F	200	0.70	0.19	0.10	0.01	0.01
SHUSWAP	SU	296	0.76	0.23	0.00	0.00	0.00
BOWRON	SF	300	0.74	0.06	0.00	0.00	0.00
HARRISON	F	292	0.73	0.27	0.00	0.00	0.00
SQUAMISH	SU	282	0.05	0.13	0.00	0.00	0.00
BELLA COOLA	SU	278	0.72	0.28	0.00	0.00	0.00
DEEP CREEK	SU	270	0.90	0.10	0.00	0.00	0.00

LOCUS: DPEF 1

POPULATION	RUN	N	ALLELE FREQUENCIES 100	90	110	76	
WENATCHEE	SU	100	0.94	0.06	0.00	0.00	0.00
OKANOGAN	su	100	0.79	0.00	0.00	0.01	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	200	0.86	0.15	0.00	0.00	0.00
RAPID RIVER	SF	200	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	200	0.71	0.09	0.00	0.00	0.00
LYONS FERRY	F	200	0.98	0.02	0.00	0.00	0.00
COLE RIVERS	SP	88	0.97	0.03	0.00	0.00	0.00
ROCK CREEK	SP	198	0.05	0.15	0.00	0.00	0.00
CEDAR CREEK	SF'	200	0.72	0.29	0.00	0.00	0.00
TRASK	SP	198	0.73	0.27	0.00	0.00	0.00
COLE RIVERS	F	200	0.97	0.03	0.00	0.00	0.00
ELK	F	190	0.69	0.31	0.00	0.00	0.00
FALL CREEK	F	200	0.72	0.20	0.00	0.00	0.00
SALMON	F	200	0.67	0.33	0.00	0.00	0.00
TRASK	F	200	0.73	0.28	0.00	0.00	0.00
SHUSWAP	SU	296	0.93	0.07	0.00	0.00	0.00
BOWRON	SP	300	0.75	0.05	0.00	0.00	0.00
HARRISON	F	300	0.99	0.01	0.00	0.00	0.00
SQUAMISH	su	300	0.99	0.01	0.00	0.00	0.00
BELLA COOLA	SU	298	0.99	0.01	0.00	0.00	0.00
DEEP CREEK	su	300	0.75	0.05	0.00	0.00	0.00

LOCUS: FBALD3

POPULATION	RUN	N	ALLELE FREQUENCIES 100	89			
WENATCHEE	SU	100	1.00	0.00	0.00	0.00	0.00
OKANOGAN	SU	100	1.00	0.00	0.00	0.00	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	200	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	200	0.97	0.03	0.00	0.00	0.00
WASHOUGAL	F	200	0.99	0.01	0.00	0.00	0.00
LYONS FERRY	F	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	SP	0	0.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	190	1.00	0.00	0.00	0.00	0.00
TRASK	SP	180	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	200	1.00	0.00	0.00	0.00	0.00
ELK	F	156	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	170	1.00	0.00	0.00	0.00	0.00
SHUSWAP	SU	296	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	272	1.00	0.00	0.00	0.00	0.00
HARRISON	F	300	1.00	0.00	0.00	0.00	0.00
SQUAMISH	SU	300	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	SU	294	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	SU	284	1.00	0.00	0.00	0.00	0.00

LOCUS a GAPDH2

POPULATION	HUN	N	ALLELE FREQUENCIES 100	112			
WENATCHEE	SU	100	1.00	0.00	0.00	0.00	0.00
OKANOGAN	su	100	1.00	0.00	0.00	0.00	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	200	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	200	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	200	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	SF	100	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SF	200	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
TRASK	SP	200	1.00	0.00	0.00	0.00	0.00
COLE River	F	200	1.00	0.00	0.00	0.00	0.00
ELK	F	200	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	200	1.00	0.00	0.00	0.00	0.00
SHUSWAP	su	300	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	100	0.99	0.01	0.00	0.00	0.00
HARRISON	F	300	1.00	0.00	0.00	0.00	0.00
SQUAMISH	SU	300	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	su	298	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	su	292	1.00	0.00	0.00	0.00	0.00

LOCUS: GPI3

POPULATION	RUN	N	ALLELE FREQUENCIES 100	105	93	85	
WENATCHEE	SU	100	1.00	0.00	0.00	0.00	0.00
OKANOGAN	SU	100	1.00	0.00	0.00	0.00	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	200	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	200	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	200	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	SP	72	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
TRASK	SP	198	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	196	1.00	0.00	0.00	0.00	0.00
ELK	F	200	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	200	1.00	0.00	0.00	0.00	0.00
SHUSWAP	SU	298	0.96	0.04	0.00	0.00	0.00
BOWRON	SP	300	0.90	0.10	0.00	0.00	0.00
HARRISON	F	200	0.96	0.04	0.01	0.00	0.00
SQUAMISH	SU	294	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	SU	298	0.99	0.01	0.00	0.00	0.00
DEEP CREEK	SU	298	0.94	0.06	0.00	0.00	0.00

LOCUS: GPIH

POPULATION	RUN	N	GENOTYPE FREQUENCIES **	***			
WENATCHEE	SU	100	0.96	0.04	0.00	0.00	0.00
OKANOGAN	SU	100	1.00	0.00	0.00	0.00	0.00
NACHES	SF	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	198	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	200	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	200	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	196	0.97	0.03	0.00	0.00	0.00
COLE RIVERS	SP	80	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
TRASK	SP	194	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	196	0.99	0.01	0.00	0.00	0.00
ELK	F	200	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	198	1.00	0.00	0.00	0.00	0.00
TRASK	F	200	1.00	0.00	0.00	0.00	0.00
SHUSWAP	SU	192	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	300	1.00	0.00	0.00	0.00	0.00
HARRISON	F	192	1.00	0.00	0.00	0.00	0.00
SQUAMISH	SU	288	0.93	0.07	0.00	0.00	0.00
BELLA COOLA	SU	198	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	SU	294	1.00	0.00	0.00	0.00	0.00

** FREQUENCY OF GENOTYPE WITH GPI1/GPI3 HETERODIMER PRESENT
*** FREQUENCY OF GENOTYPE WITH GPI1/GPI3 HETERODIMER MISSING

LOCUS: GR

POPULATION	RUN	N	ALLELE FREQUENCIES 100	85	110		
WENATCHEE	SU	100	0.98	0.02	0.00	0.00	0.00
OKANOGAN	SU	100	0.91	0.09	0.00	0.00	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	192	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	200	1.00	0.01	0.00	0.00	0.00
WASHOUGAL	F	180	0.78	0.22	0.00	0.00	0.00
LYONS FERRY	F	194	0.99	0.02	0.00	0.00	0.00
COLE RIVERS	SP	100	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	200	0.87	0.14	0.00	0.00	0.00
CEDAR CREEK	SP	194	0.93	0.07	0.00	0.00	0.00
TRASK	SP	200	0.94	0.06	0.00	0.00	0.00
COLE RIVERS	F	200	1.00	0.01	0.00	0.00	0.00
ELK	F	196	0.99	0.02	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	200	1.00	0.00	0.00	0.00	0.00
SHUSWAP	SU	200	0.79	0.14	0.08	0.00	0.00
BOWRON	SP	296	0.86	0.02	0.12	0.00	0.00
HARRISON	F	180	0.62	0.32	0.06	0.00	0.00
SQUAMISH	SU	280	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	SU	198	0.99	0.00	0.02	0.00	0.00
DEEP CREEK	SU	192	0.93	0.05	0.02	0.00	0.00

LOCUS: IDH2

POPULATION	RUN	N	ALLELE FREQUENCIES 100	154			
WENATCHEE	SU	100	1.00	0.00	0.00	0.00	0.00
OKANOGAN	SU	100	1.00	0.00	0.00	0.00	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	200	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	200	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	200	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	198	0.99	0.01	0.00	0.00	0.00
COLE RIVERS	SP	98	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	196	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
TRASK	SP	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	200	1.00	0.00	0.00	0.00	0.00
ELK	F	200	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	186	1.00	0.00	0.00	0.00	0.00
TRASK	F	186	1.00	0.00	0.00	0.00	0.00
SHUSWAP	SU	100	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	298	1.00	0.00	0.00	0.00	0.00
HARRISON	F	300	1.00	0.00	0.00	0.00	0.00
SQUAMISH	SU	200	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	SU	100	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	SU	286	1.00	0.00	0.00	0.00	0.00

LOCUS: IDH34

POPULATION	RUN	N	ALLELE FREQUENCIES 100	127	74	142	50
WENATCHEE	SU	200	0.89	0.10	0.01	0.00	0.00
OKANOGAN	SU	200	0.92	0.08	0.00	0.00	0.00
NACHES	SP	200	0.95	0.01	0.05	0.00	0.00
TUCANNON	SP	400	0.90	0.00	0.10	0.00	0.00
RAPID RIVER	SP	400	0.96	0.00	0.04	0.00	0.00
WASHOUGAL	F	400	0.95	0.02	0.03	0.00	0.00
LYONS FERRY	F	390	0.96	0.04	0.00	0.00	0.00
COLE RIVERS	SP	196	0.95	0.05	0.00	0.00	0.00
ROCK CREEK	SP	400	0.96	0.04	0.00	0.00	0.00
CEDAR CREEK	SP	400	0.97	0.03	0.00	0.00	0.00
TRASK	SP	400	0.99	0.01	0.00	0.00	0.00
COLE RIVERS	F	400	0.98	0.02	0.00	0.00	0.00
ELK	F	392	0.93	0.07	0.00	0.00	0.00
FALL CREEK	F	400	0.97	0.03	0.00	0.00	0.00
SALMON	F	400	0.96	0.04	0.00	0.00	0.00
TRASK	F	400	1.00	0.01	0.00	0.00	0.00
SHUSWAP	SU	200	0.95	0.00	0.01	0.00	0.04
BOWRON	SP	600	1.00	0.00	0.00	0.00	0.00
HARRISON	F	600	0.96	0.03	0.01	0.00	0.00
SQUAMISH	SU	400	0.97	0.02	0.01	0.00	0.00
BELLA COOLA	SU	200	1.00	0.00	0.01	0.00	0.00
DEEP CREEK	SU	400	1.00	0.00	0.00	0.00	0.00

LOCUS: LDH4

POPULATION	RUN	N	ALLELE FREQUENCIES 100	112	134	71	
WENATCHEE	SU	100	1.00	0.00	0.00	0.00	0.00
OKANOGAN	su	100	1.00	0.00	0.00	0.00	0.00
NACHES	SF	100	X.00	0.00	0.00	0.00	0.00
TUCANNON	SP	200	0.99	0.02	0.00	0.00	0.00
RAPID RIVER	SF	200	1.00	0.01	0.00	0.00	0.00
WASHOUGAL	F	200	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	sip	100	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
TRASK	SF	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	200	1.00	0.00	0.01	0.00	0.00
ELK	F	198	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	200	1.00	0.00	0.00	0.00	0.00
SHUSWAP	SU	300	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	300	1.00	0.00	0.00	0.00	0.00
HARRISON	F	300	1.00	0.00	0.00	0.00	0.00
SQUAMISH	su	300	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	su	298	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	su	300	1.00	0.00	0.00	0.00	0.00

LOCUS: LDHS

POPULATION	RUN	N	ALLELE FREQUENCIES 100	90	70		
WENATCHEE	SU	100	0.96	0.04	0.00	0.00	0.00
OKANOGAN	SU	100	0.95	0.05	0.00	0.00	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	198	0.98	0.02	0.00	0.00	0.00
RAPID RIVER	SP	200	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	198	1.00	0.01	0.00	0.00	0.00
LYONS FERRY	F	200	1.00	0.01	0.00	0.00	0.00
COLE RIVERS	SP	100	0.99	0.01	0.00	0.00	0.00
ROCK CREEK	SP	194	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	198	0.92	0.08	0.00	0.00	0.00
TRASK	SP	188	0.98	0.02	0.00	0.00	0.00
COLE RIVERS	F	192	0.99	0.01	0.00	0.00	0.00
ELK	F	200	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	196	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	200	1.00	0.00	0.00	0.00	0.00
SHUSWAP	SU	290	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	300	1.00	0.00	0.00	0.00	0.00
HARRISON	F	300	0.98	0.02	0.00	0.00	0.00
SQUAMISH	SU	294	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	SU	298	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	SU	294	0.99	0.01	0.00	0.00	0.00

LOCUS: MDH12

POPULATION	RUN	N	ALLELE FREQUENCIES 100	120	27	-45	
WENATCHEE	SU	200	1.00	0.00	0.00	0.00	0.00
OKANOGAN	SU	200	1.00	0.00	0.00	0.00	0.00
NACHES	SP	200	1.00	0.00	0.00	0.00	0.00
TUCRNNON	SF	400	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	400	1.00	0.00	0.00	0.00	0.00
WRSHOUEAL	F	400	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	400	1.00	0.00	0.00	0.00	0.00
COLE River	SP	200	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	400	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	400	1.00	0.00	0.00	0.00	0.00
TRASK	SP	400	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	400	1.00	0.00	0.00	0.00	0.00
ELK	F	384	0.94	0.00	0.06	0.00	0.00
FALL CREEK	F	388	1.00	0.00	0.00	0.00	0.00
SALMON	F	400	1.00	0.00	0.00	0.00	0.00
TRASK	F	400	1.00	0.00	0.00	0.00	0.00
SHUSWAP	su	592	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	600	1.00	0.00	0.00	0.00	0.00
HARRISUN	F	600	1.00	0.00	0.00	0.00	0.00
SQUAM I SH	su	600	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	su	596	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	su	592	1.00	0.00	0.00	0.00	0.00

LOCUS: MDH34

POPULATION	RUN	N	ALLELE FREQUENCIES 100	121	70	83	
WENATCHEE	SU	200	0.96	0.01	0.04	0.00	0.00
OKANOGAN	SU	200	0.96	0.02	0.03	0.00	0.00
NACHES	SP	200	0.98	0.01	0.02	0.00	0.00
TUCANNON	SP	400	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	400	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	392	0.96	0.04	0.00	0.00	0.00
LYONS FERRY	F	400	0.97	0.01	0.02	0.00	0.00
COLE RIVERS	SP	200	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	400	0.96	0.04	0.00	0.00	0.00
CEDAR CREEK	SP	400	0.98	0.02	0.00	0.00	0.00
TRASK	SP	400	0.98	0.02	0.00	0.00	0.00
COLE RIVERS	F	400	1.00	0.00	0.00	0.00	0.00
ELK	F	400	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	388	1.00	0.00	0.00	0.00	0.00
SALMON	F	400	1.00	0.00	0.00	0.00	0.00
TRASK	F	400	0.99	0.01	0.00	0.00	0.00
SHUSWAP	SU	592	0.98	0.03	0.00	0.00	0.00
BOWRON	SP	600	0.97	0.00	0.03	0.00	0.00
HARRISON	F	600	0.92	0.05	0.03	0.00	0.00
SQUAMISH	SU	600	0.92	0.08	0.00	0.00	0.00
BELLA COOLA	SU	552	0.98	0.00	0.02	0.00	0.00
DEEP CREEK	SU	596	1.00	0.00	0.00	0.00	0.00

LOCUS: MPI

POPULATION	RUN	N	ALLELE FREQUENCIES 100	109	95	113	
WENATCHEE	su	100	0.65	0.37	0.00	0.00	0.00
OKANOGAN	su	100	0.63	0.37	0.00	0.00	0.00
NACHES	SF	92	0.77	0.23	0.00	0.00	0.00
TUCANNON	SF	200	0.85	0.15	0.00	0.00	0.00
RAPID RIVER	SF	200	0.94	0.07	0.00	0.00	0.00
WASHOUGAL	F	200	0.51	0.46	0.03	0.00	0.00
LYONS FERRY	F	198	0.76	0.23	0.01	0.00	0.00
COLE RIVERS	SP	100	0.00	0.12	0.00	0.00	0.00
ROCK CREEK	SF	200	0.76	0.24	0.00	0.00	0.00
CEDAR CREEK	SF	200	0.71	0.29	0.00	0.00	0.00
TRASK	SF	200	0.59	0.40	0.00	0.02	0.00
COLE RIVERS	F	200	0.93	0.07	0.00	0.00	0.00
ELK	F	200	0.58	0.42	0.00	0.00	0.00
FALL CREEK	F	190	0.65	0.35	0.00	0.00	0.00
SALMON	F	200	0.78	0.22	0.00	0.00	0.00
TRASK	F	196	0.73	0.27	0.00	0.00	0.00
SHUSWAP	SU	298	0.67	0.33	0.00	0.00	0.00
BOWRON	SF	292	0.68	0.33	0.00	0.00	0.00
HARRISON	F	294	0.52	0.48	0.00	0.00	0.00
SQUAMISH	su	294	0.09	0.11	0.00	0.00	0.00
BELLA COOLA	SU	294	0.79	0.21	0.01	0.00	0.00
DEEP CREEK	SU	296	0.63	0.37	0.00	0.00	0.00

LOCUS: PDPEP2

POPULATION	RUN	N	ALLELE FREQUENCIES				
			100	107			
WENATCHEE	SU	100	1.00	0.00	0.00	0.00	0.00
OKANOGAN	SU	100	0.99	0.01	0.00	0.00	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	198	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	200	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	200	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	200	1.00	0.01	0.00	0.00	0.00
COLE RIVERS	SP	100	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
TRASK	SP	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	198	1.00	0.00	0.00	0.00	0.00
ELK	F	194	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	100	0.95	0.05	0.00	0.00	0.00
SHUSWAP	SU	200	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	300	1.00	0.00	0.00	0.00	0.00
HARRISON	F	300	1.00	0.00	0.00	0.00	0.00
SQUAMISH	SU	298	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	SU	294	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	SU	300	1.00	0.00	0.00	0.00	0.00

LOCUS: PEPLT

POPULATION	RUN	N	ALLELE FREQUENCIES 100	110			
WENATCHEE	SU	100	0.76	0.24	0.00	0.00	0.00
OKANOGAN	SU	100	0.64	0.36	0.00	0.00	0.00
NACHES	SP	100	0.99	0.01	0.00	0.00	0.00
TUCANNON	SP	174	0.98	0.02	0.00	0.00	0.00
RAPID RIVER	SP	200	0.97	0.04	0.00	0.00	0.00
WASHOUGAL	F	176	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	198	0.90	0.10	0.00	0.00	0.00
COLE RIVERS	SP	96	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	200	0.99	0.01	0.00	0.00	0.00
CEDAR CREEK	SP	194	1.00	0.00	0.00	0.00	0.00
TRASK	SP	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	200	0.99	0.02	0.00	0.00	0.00
ELK	F	200	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	200	1.00	0.00	0.00	0.00	0.00
SHUSWAP	SU	298	0.99	0.01	0.00	0.00	0.00
BOWRON	SP	298	0.94	0.06	0.00	0.00	0.00
HARRISON	F	270	0.99	0.01	0.00	0.00	0.00
SQUAMISH	SU	282	0.80	0.20	0.00	0.00	0.00
BELLA COOLA	SU	296	0.95	0.05	0.00	0.00	0.00
DEEP CREEK	SU	296	0.94	0.06	0.00	0.00	0.00

LOCUS: PGDH

POPULATION	RUN	N	ALLELE FREQUENCIES 100	90	85		
WENATCHEE	SU	100	1.00	0.00	0.00	0.00	0.00
OKANOGAN	SU	100	1.00	0.00	0.00	0.00	0.00
NACHES	SP	100	1.00	0.00	0.00	0.00	0.00
TUCANNON	SP	200	1.00	0.00	0.00	0.00	0.00
RAPID RIVER	SP	200	1.00	0.00	0.00	0.00	0.00
WASHOUGAL	F	196	1.00	0.00	0.00	0.00	0.00
LYONS FERRY	F	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	SP	100	1.00	0.00	0.00	0.00	0.00
ROCK CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
CEDAR CREEK	SP	200	1.00	0.00	0.00	0.00	0.00
TRASK	SP	200	1.00	0.00	0.00	0.00	0.00
COLE RIVERS	F	200	1.00	0.01	0.00	0.00	0.00
ELK	F	200	1.00	0.00	0.00	0.00	0.00
FALL CREEK	F	200	1.00	0.00	0.00	0.00	0.00
SALMON	F	200	1.00	0.00	0.00	0.00	0.00
TRASK	F	200	1.00	0.00	0.00	0.00	0.00
SHUSWAP	SU	300	0.99	0.01	0.00	0.00	0.00
BOWRON	SP	300	1.00	0.00	0.00	0.00	0.00
HARRISON	F	300	1.00	0.00	0.00	0.00	0.00
SQUAMISH	SU	300	1.00	0.00	0.00	0.00	0.00
BELLA COOLA	SU	270	1.00	0.00	0.00	0.00	0.00
DEEP CREEK	SU	198	1.00	0.00	0.00	0.00	0.00

LOCUS: PGK2

POPULATIUN	RUN	N	ALLELE FREQUENCIES 100	90			
WENATCHEE	su	100	0.58	0.42	0.00	0.00	0.00
OKANOGAN	su	100	0.60	0.32	0.00	0.00	0.00
NACHES	SF	100	0.30	0.62	0.00	0.00	0.00
TUCANNON	SP	192	0.15	0.85	0.00	0.00	0.00
RAPID RIVER	SF	200	0.08	0.92	0.00	0.00	0.00
WASHOUGAL	F	200	0.73	0.28	0.00	0.00	0.00
LYONS FERRY	F	196	0.54	0.46	0.00	0.00	0.00
COLER RIVERS	SP	98	0.49	0.51	0.00	0.00	0.00
ROCK CREEK	SF	200	0.64	0.36	0.00	0.00	0.00
CEDAR CREEK	SP	198	0.47	0.53	0.00	0.00	0.00
TRASK	SP	194	0.44	0.56	0.00	0.00	0.00
COLE RIVERS	F	200′	0.32	0.68	0.00	0.00	0.00
ELK	F	200	0.38	0.63	0.00	0.00	0.00
FALL CREEK	F	192	0.45	0.55	0.00	0.00	0.00
SALMON	F	200	0.39	0.61	0.00	0.00	0.00
TRASK	F	200	0.45	0.56	0.00	0.00	0.00
SHUSWAF	su	300	0.56	0.44	0.00	0.00	0.00
BOWRON	SP	300	0.23	0.77	0.00	0.00	0.00
HARRSON	F	296	0.27	0.73	0.00	0.00	0.00
SQUAM SH	su	292	0.41	0.59	0.00	0.00	0.00
BELLA COOLA	su	298	0.19	0.82	0.00	0.00	0.00
DEEP CREDK	su	294	0.21	0.79	0.00	0.00	0.00

LOCUS: SOD1

POPULATION	RUN	N	ALLELE FREQUENCIES -100	-260	580	1260	
WENATCHEE	SU	100	0.46	0.53	0.01	0.00	0.00
OKANOGAN	SU	100	0.52	0.48	0.00	0.00	0.00
NACHES	SP	98	0.70	0.30	0.00	0.00	0.00
TUCANNON	SP	200	0.88	0.13	0.00	0.00	0.00
RAPID RIVER	SP	200	0.89	0.11	0.00	0.00	0.00
WASHOUGAL	F	200	0.48	0.52	0.00	0.00	0.00
LYONS FERRY	F	198	0.65	0.35	0.00	0.00	0.00
COLE RIVERS	SP	98	0.82	0.17	0.01	0.00	0.00
ROCK CREEK	SP	200	0.65	0.32	0.04	0.00	0.00
CEDAR CREEK	SP	196	0.65	0.35	0.00	0.00	0.00
TRASK	SP	198	0.84	0.16	0.00	0.00	0.00
COLE RIVERS	F	200	0.86	0.14	0.01	0.00	0.00
ELK	F	198	0.71	0.29	0.00	0.00	0.00
FALL CREEK	F	196	0.83	0.17	0.01	0.00	0.00
SALMON	F	200	0.81	0.19	0.00	0.00	0.00
TRASK	F	200	0.82	0.18	0.00	0.00	0.00
SHUSWAP	SU	300	1.00	0.00	0.00	0.00	0.00
BOWRON	SP	298	0.92	0.06	0.02	0.00	0.00
HARRISON	F	296	0.91	0.08	0.02	0.00	0.00
SQUAMISH	SU	296	0.85	0.13	0.02	0.00	0.00
BELLA COOLA	SU	182	0.75	0.25	0.01	0.00	0.00
DEEP CREEK	SU	294	0.78	0.22	0.00	0.00	0.00

LOCUS : TAPEP1

FOFULATION	RUN	N	ALLELE FREQUENCIES 100	130	45	68	
WENATCHEE	su	100	0.74	0.26	0.00	0.00	0.00
OKANOGAN	su	96	0.69	0.31	0.00	0.00	0.00
NACHES	SP	98	0.90	0.02	0.00	0.00	0.00
TUCANNON	SP	200	0.98	0.02	0.00	0.00	0.00
RAPID RIVER	SF'	196	0.89	0.11	0.00	0.00	0.00
WASHOUGAL	F	192	0.83	0.17	0.00	0.00	0.00
LYONS FERRY	F	200	0.89	0.11	0.00	0.00	0.00
COLE RIVERS	SP	100	0.92	0.08	0.00	0.00	0.00
ROCK CREEK	SF	188	0.92	0.09	0.00	0.00	0.00
CEDAR CREEK	SF	198	0.90	0.10	0.00	0.00	0.00
TRASK	SP.	192	0.88	0.12	0.00	0.00	0.00
COLE RIVERS	F	188	0.98	0.02	0.00	0.00	0.00
ELK	F	200	0.95	0.05	0.00	0.00	0.00
FALL CREEK	F	192	0.85	0.15	0.00	0.00	0.00
SALMON	F .	200	0.95	0.05	0.00	0.00	0.00
TRASK	F	19%	0.80	0.20	0.00	0.70	0.00
SHUSWAF	su	296	0.99	0.01	0.00	0.30	0.00
BOWRON	SP.	300	1.00	0.00	0.00	0.00	0.00
HARRISON	F	296	0.66	0.34	0.00	0.00	0.00
SQUAMISH	su	298	0.56	0.44	0.00	0.00	0.00
BELLA COOLA	su	294	0.93	0.07	0.00	0.00	0.00
DEEP CHEEK	su	300	1.00	0.00	0.00	0.00	0.00

APPENDIX C

Results of a Simulated Ocean Mixed Stock Fishery from Northern California

Appendix Table C.--Northern

Individual stocks						
Mixed fishery sample size - 250 fish						
River of origin	Race	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Feather	Spring	5.0	6.30	26.00	6.35	100.8
Feather-Nimbus	Fall	20.0	17.71	-11.45	8.73	49.3
Irongate-Shasta-Scott	"	10.0	10.82	8.20	8.46	78.2
Trinity	Spring & Fall	13.0	11.07	-14.85	8.74	79.0
Mattole-Eel	Fall	16.0	14.30	-10.62	9.52	66.6
Mad	"	1.0	4.75	375.00	7.85	165.3
Smith	"	4.0	3.36	-16.00	4.70	139.9
Nehalem	"	1.0	0.63	-37.00	1.42	225.4
Tillamook	"	1.0	2.11	111.11	4.20	199.1
Trask	"	1.0	1.05	5.00	2.15	204.8
Suislaw	"	1.0	1.56	5.60	2.46	157.7
Rock Creek	Spring	4.0	5.12	28.00	4.60	89.8
Coquille	Fall	1.0	0.85	-15.00	1.89	222.4
Cole R.-Hoot Owl	Spring	10.0	9.65	-3.50	7.37	76.4
Cole R.	Fall	4.0	3.02	-24.50	5.88	194.7
Lobster	"	1.0	0.89	-11.00	1.75	196.6
Applegate	"	1.0	1.38	38.00	2.85	206.5
Elk	"	1.0	0.93	-7.00	1.51	162.4
Chetco-Winchuk	"	2.0	2.25	12.50	4.34	192.9
Washougal	"	2.0	1.56	-22.00	2.02	129.5
Rapid R.	Spring	1.0	0.69	-31 .oo	1.24	179.7
			100.00	0.00		

Appendix Table C.--Northern

			Individual tocks			
			Mixed fishery sample size = 500 fish			
River of origin	Race	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Feather	Spring	5.0	5.19	3.80	4.29	82.7
Feather-Nimbus	Fall	20.0	19.81	-0.95	6.18	31.2
Irongate-Shasta-Scott	Fall	10.0	9.01	-9.90	5.43	60.3
Trinity	Spring & fall	13.0	13.71	5.46	6.07	44.3
Mattole-Eel	Fall	16.0	14.44	-9.75	4.81	33.3
Mad	"	1.0	3.14	214.00	3.67	116.9
Smith	"	4.0	3.07	-23.30	4.47	145.6
Nehalem	"	1.0	0.96	-4.00	1.52	158.3
Tillamook	"	1.0	1.71	71.00	3.08	180.1
Trask	"	1.0	0.99	-1.00	1.52	153.5
Suislaw	"	1.0	1.01	1.00	2.09	206.9
Rock Creek	Spring	4.0	4.03	0.75	2.32	57.6
Coquille	Fall	1.0	0.81	-19.00	1.18	145.7
Cole R.-Hoot Owl	Spring	10.0	9.71	-2.90	4.70	48.4
Cole R.	Fall	4.0	3.90	-2.50	5.86	150.3
Lobster	"	1.0	1.18	18.00	1.40	118.6
Applegate	"	1.0	0.96	-4.00	1.84	191.7
Elk	"	1.0	0.93	-7.00	1.38	148.4
Chetco-Winchuck	"	2.0	2.37	18.15	3.66	154.4
Washougal	"	2.0	2.05	2.50	1.37	66.8
Rapid River	Spring	1.0	1.02	2.00	1.19	116.7
			100.00	0.00		

Appendix Table C.--Northern

Individual stocks						
		Mixed fishery sample size - 1,000 fish				
River of origin	Race	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Feather	Spring	5.0	5.26	5.20	2.73	51.9
Feather-Nimbus	**Fall**	20.0	20.13	0.65	4.04	20.1
Irongate-Shasta-Scott	Fall	10.0	9.35	-6.50	4.66	49.8
Trinity	Spring & fall	13.0	13.77	5.92	5.18	37.6
Xattole-Eel	Fall	16.0	15.21	-4.94	4.16	27.4
Mad	'	1.0	1.72	72.00	2.83	164.5
Smith	"	4.0	4.09	2.25	2.78	168.0
Nehalem	"	1.0	1.17	17.00	1.37	117.0
Ti llamook	"	1.0	1.03	3.00	1.70	165.0
trask	"	1.0	0.69	-31 .oo	0.81	117.4
Suislaw	"	1.0	0.95	-5.00	1.42	149.5
Rock Creek	Spring	4.0	3.81	- 0.75	1.75	45.9
Coquille	Fall	1.0	0.89	-11.00	1.10	123.6
Cole R.-Hoot Owl	Spring	10.0	9.40	-6.00	3.43	36.5
Cole R.	Fall	4.0	3.76	-6.00	**4.25**	**113.0**
Lobster	"	1.0	0.94	-6.00	0.91	96.8
Applegate	"	1.0	1.20	30.00	1.72	143.3
Elk	"	1.0	0.94	-6.00	1.09	116.0
Chetco-Winchuk	"	2.0	2.67	33.50	3.32	124.3
Washougal	"	2.0	2.12	6.00	0.99	46.7
Rapid R.	Spring	1.0	0.90	-10.00	0.83	92.2
			100.00	0.00		

Appendix Table C.--Northern

Stock groupings					
	Mixed fishery sample size = 250 fish				
Management unit	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Sacramento	25.0	24.01	-3.96	6.30	26.2
Klamath	23.0	21.89	-4.83	5.44	24.9
Mattole-Eel	16.0	14.30	-10.63	9.52	66.6
Mad, Smith	5.0	8.11	62.20	7.81	96.3
Mattole-Eel, Mad, Smith	21.0	22.42	6.76	11.07	49.4
Rogue	16.0	14.94	-6.63	9.98	66.8
Elk, Chetco-Winchuk	3.0	3.18	6.00	4.66	146.5
Rogue, Elk, Chetco, Winchuk	19.0	18.12	-4.63	10.59	58.4
Nehalem, Tillamook, Trask, Suuishaw, Rock, Coquille	9.0	11.31	25.67	6.49	57.4
Columbia	3.0	2.25	25.00	2.43	108.0
All except Sacramento and Klamath	52.0	54.10	4.04	14.36	26.5

Appendix Table C.--Northern

	Stock groupings				
	Mixed fishery sample size = 500 fish				
Management unit	Actual contribution	Mean estimated contribution	Differences est./actual	1.28 SD	1.28 SD / estimate
Sacramento	25.0	25.00	0.00	4.42	17.7
Klamath	23.0	22.72	-1.22	4.02	17.7
Mattole-Eel	16.0	14.44	-9.75	4.81	33.3
Mad, Smith	5.0	6.21	24.20	5.40	87.0
Mattole-Eel, Mad, Smith	21.0	20.65	-1.67	6.67	32.0
Rogue	16.0	15.75	-1.56	6.80	43.2
Elk, Chetco-Winchuk	3.0	3.30	10.00	3.84	116.4
Rogue, Elk, Chetco-Winchuk	19.0	19.05	0.26	7.09	37.2
Nehalem, Tillamook, Trask, Suislaw, Rock, Coquille	9.0	9.51	5.67	4.26	44.8
Columbia	3.0	3.07	2.33	1.77	57.7
All except Sacramento and Klamath	52.0	52.28	0.54	9.08	17.4

Appendix Table C.--Northern

Management unit	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Stock groupings					
		Mixed fishery sample size = 1,000 fish			
Sacramento	25.0	25.40	1.60	2.75	10.83
Klamath	23.0	23.11	0.48	2.39 ,	10.34
Mattole-Eel	16.0	15.21	-4.94	4.16	27.35
Mad, Smith	5.0	5.81	16.20	3.99	66.78
Mattole-Eel, Mad, Smith	21.0	21.02	0.10	5.27	25.07
Rogue	16.0	15.30	-4.38	4.56	29.80
Elkk, Chetco-Winchuk	3.0	3.60	20.00	3.23	89.72
Rogue, Elk, Chetco, Winchuk	19.0	18.90	-0.53	5.30	28.04
Sehaiem, Tillamook, Trask, Suishaw, Rock, Coquille	9.0	8.54	-5.11	2.70	31.62
Columbia	3.0	3.03	1.00	1.31	43.23
All except Sacramento and Klamath	52.0	51.48	-0.00	6.58	12.78

APPENDIX D

Results of a Simulated Ocean Mixed Stock Fishery from Central California

Appendix Table D.--Central

Individual stocks						
Mixed fishery sample size = 250 fish						
River of origin	Race	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Feather	Spring	11.0	11.79	2.64	9.26	78.5
Feather-Nimbus	Fall	78.0	75.70	-2.90	11.47	15.1
Irongate-Shasta-Scott	Fall	2.0	1.81	-9.50	2.41	133.0
Trinity	Spring & fall	2.0	1.92	-4.00	2.90	151.3
Mattole-Eel	Fall	3.0	3.14	4.67	4.87	154.9
Mad	"	0.5	1.29	158.00	2.74	212.3
Smith	"	0.5	0.36	-28.00	1.16	323.6
Sehalem	"	0.1	0.30	200.00	0.83	277.3
Tillamook	"	0.1	0.54	440.00	1.83	339.0
Trask	"	0.1	0.12	20.00	0.63	522.7
Suislaw	"	0.1	0.08	-20.00	0.39	480.0
Rock Creek	Spring	0.2	0.27	35.00	0.82	305.2
Coquille	Fall	0.1	0.08	- 20.00	0.29	377.4
Cole R.-Hoot Owl	Spring	0.2	0.21	5.00	0.90	436.8
Cole R.	Fall	0.2	0.41	105.00	1.30	318.4
Lobster	"	0.3	0.44	46.67	1.23	279.3
Applegate	"	0.2	0.24	20.00	0.74	309.3
Elk	"	0.2	0.08	-6.00	0.36	448.0
Chetco-Winchuk	"	0.2	0.22	10.00	0.99	448.0
Washougal	"	0.5	0.50	0.00	0.98	196.3
Rapid River	Spring	0.5	0.50	0.00	1.20	238.4
			100.0	0.00		

Appendix Table D.--Central

Individual stocks						
		Mixed fishery sample size = 500 fish				
River of origin	Race	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Feather	Spring	11.0	10.44	-5.09	6.52	62.4
Feather-Nimbus	Fall	78.0	77.60	-0.51	7.55	9.7
Irongate-Shasta-Scott	Fall	2.0	1.87	-6.50	2.10	112.3
Trinity	Spring & fall	2.0	1.95	-2.50	2.21	113.6
Mattole-Eel	Fall	3.0	3.19	6.33	3.71	116.4
Mad	"	0.5	1.47	94.00	2.96	195.0
Smith	"	0.5	0.23	54.00	0.86	372.9
Nehalem	"	0.1	0.11	10.00	0.29	256.0
Tillamook	"	0.1	0.37	270.00	1.41	380.5
Trask	"	0.1	0.10	0.00	0.42	422.4
Suislaw	"	0.1	0.13	30.00	0.36	275.7
Rock Creek	Spring	0.2	0.37	85.00	0.73	197.2
Coquille	Fall	0.1	0.06	-40.00	0.21	341.3
Cole R.-Hoot Owl	Spring	0.2	0.12	40.00	0.45	373.3
Cole R.	Fall	0.2	0.44	120.00	1.22	276.4
Lobster	"	0.3	0.24	-20.00	0.60	250.7
Applegate	"	0.2	0.14	-30.00	0.45	321.4
Elk	"	0.2	0.16	-20.00	0.51	318.7
Chetco-Winchuk	"	0.2	0.31	55.00	0.86	276.6
Washougal	"	0.5	0.40	-20.00	0.46	115.2
Rapid River	Spring	0.5	0.30	-40.00	0.59	196.3
			100.0	0.00		

Appendix Table D.--Central

Individual stocks						
Mixed fishery sample size = 1,000 fish						
River of origin	Race	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Feather	Spring	11.0	11.29	2.64	4.21	37.3
Feather-Nimbus	Fall	78.0	77.69	-0.40	5.26	6.8
Irongate-Shasta-Scott	Fall	2.0	2.15	7.50	1.40	64.9
Trinity	Spring & fall	2.0	1.66	-17.00	1.90	114.1
Mattole-Eel	Fall	3.0	2.41	-19.67	2.43	100.9
Mad	"	0.5	1.17	134.00	1.56	134.6
Smith	"	0.5	0.53	6.00	1.09	205.3
Nehalem	"	0.1	0.05	-50.00	0.18	358.4
Tillamook	"	0.1	0.10	0.00	0.35	345.6
Trask	"	0.1	0.12	20.00	0.27	224.0
Suislaw	"	0.1	0.07	-30.00	0.23	329.1
Rock Creek	Spring	0.2	0.20	0.00	0.42	204.8
Coquille	Fall	0.1	0.09	-10.00	0.26	284.4
Cole R.-Hoot Owl	Spring	0.2	0.31	55.00	0.74	239.5
Cole R.	Fall	0.2	0.32	60.00	0.84	260.0
Lobster	"	0.3	0.15	-50.00	0.35	230.4
Applegate	"	0.2	0.11	-45.00	0.27	244.4
Elk	"	0.2	0.26	30.00	0.39	152.6
Chetco-Winchuk	"	0.2	0.44	120.00	1.04	235.6
Washougal	"	0.5	0.43	-14.00	0.44	104.2
Rapid River	Spring	0.5	0.45	-10.00	0.44	99.6
			100.0	0.00		

Appendix Table D.--Central

Stock groupings					
	Mixed fishery sample size = 250 fish				
Management unit	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Sacramento	89.0	87.5	-1.69	6.27	7.2
Klamath	4.0	3.73	-6.75	3.21	86.1
Mad, Smith	1.0	1.65	65.00	2.82	170.7
Mattole-Eel, Mad, Smith	4.0	4.79	19.75	5.45	113.8
Calif. excluding Sacramento	8.0	8.52	6.50	6.00	70.5
Oregon Coast	2.0	2.98	49 .00	3.30	110.8
Columbia R.	1.0	1.01	1.00	1.52	150.8

Appendix Table D.--Central

Stock groupings					
	Mixed fishery sample size = 500 fish				
Management unit	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Sacramento	89.0	88.04	-1.08	4.07	4.6
Klamath	4.0	3.82	-4.50	2.50	65.3
Mad, Smith	1.0	1.70	70.00	3.19	187.5
Mattole-Eel, Mad, Smith	4.0	4.89	22.25	4.38	89.5
Callf. excluding Sacramento	8.0	8.71	8.87	4.93	56.6
Oregon Coast	2.0	2.55	27.50	2.04	79.8
Columbia R.	1.0	0.70	-30.00	0.73	104.2

Appendix Table D.--Central

Stock groupings					
	Mixed fishery sample size = 1,000 fish				
Management unit	Actual contribution	Mean estimated contribution	Percent error	1.28 SD	1.28 SD / estimate
Sacramento	89.0	89.0	0.00	2.70	3.0
Klamaht	4.0	3.81	-4.75	1.88	49.4
Mad, Smith	1.0	1.70	70 .oo	2.04	119.7
Yattole-Eel, Mad, Smith	4.0	4.11	2.75	3.03	73.8
Calif. excluding Sacramento	8.0	7.92	-1 .oo	3.42	43.2
Oregon Coast	2.0	2.22	11.00	1.59	71.5
Columbia R.	1.0	0.88	-12.00	0.60	68.4

APPENDIX E

Budget Information

SUMMARY of EXPENDITURES 3/01/85 - 10/31/85

PROJECT 85-84

Electrophoresis Genetic Stock Identification

Personnel Services and Benefits	72.5
Travel Transportation of Persons	1.3
Transportation of Things	0.0
Rent, Communications & Utilities	4.7
Printing & Reproduction	0.8
Contracts & Other Services	2.1
Supplies and Materials	18.7
Equipment	0.0
Grants	0.0
Support Costs (Including DOC ovhd.)	28.1
TOTAL	128.2